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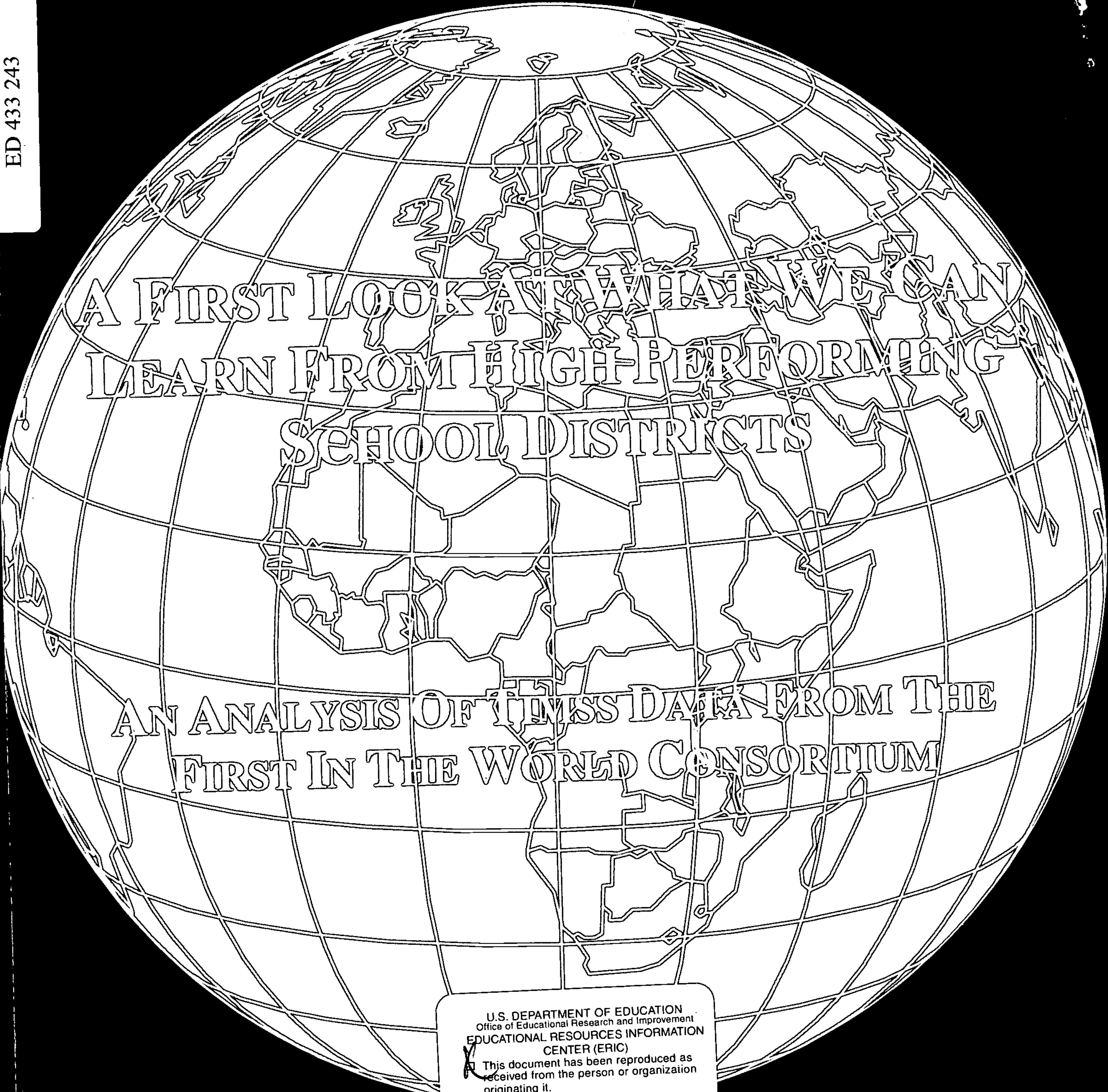
ABSTRACT

Interest in the First in the World (FiW) Consortium's activities has been intense for a number of reasons. Initial results show that the FiW Consortium is well on its way to meeting its goal, with the FiW performing at or near the top of the world on the international benchmark chosen by the Consortium--the Third International Math and Science Study (TIMSS). A status report is provided on the FiW's initial activities. The first section describes the districts that make up the FiW Consortium and outlines the Consortium's history, purpose, goals, and plan of action to become the first in the world in math and science. The second section documents how the students from the FiW Consortium performed when benchmarked against an international comparison, the TIMSS assessment. The next section discusses the impact that socio-economic variables could have on the performance of FiW students. The fourth section presents data on the contexts for teaching and learning mathematics in the FiW, exploring differences between the FiW and the U.S. and, where data are readily available, differences between the contexts for teaching in the FiW and countries with high mathematics achievement. The fifth section describes some of the activities being undertaken by the FiW Consortium to improve math and science education, highlighting a recent project that is using data from TIMSS and other sources to improve science instruction. The final section summarizes the whole report and offers some possible questions for future research. Two appendices provide: (1) contact information and characteristics of FiW Consortium Districts; and (2) 12 tables presenting FiW TIMSS Achievement Results by country. (Contains 19 references and 32 endnotes.) (ASK)



A First Look At What We Can Learn From High Performing School Districts

An Analysis Of TIMSS Data From The First In The World Consortium

National Institute on Student Achievement, Curriculum, and Assessment
U.S. Department of Education

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A FIRST LOOK AT WHAT WE CAN LEARN FROM HIGH PERFORMING SCHOOL DISTRICTS:

An Analysis of TIMSS Data From the First in the World Consortium

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August 1999

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List of Exhibits

Introduction

The efforts of a group of small school districts north of Chicago to become first in the world in math and science achievement have recently captured the interest of educators, researchers, and policymakers across the country.

Working collaboratively, rather than competitively, this unique consortium of districts has begun to benchmark its students against an international standard of achievement, identify and implement best practices for improving math and science achievement, and establish learning networks among the educators within its districts.

Interest in the First in the World (FiW) Consortium's activities has been particularly intense for a number of reasons. First, initial results show that the FiW Consortium is well on its way to meeting its goal, with the FiW performing at or near the top of the world on the international benchmark chosen by the Consortium—the Third International Math and Science Study (TIMSS).[1]

Given the disappointing performance of U.S. students on the same international math and science assessments, many believe that the approaches taken by the FiW towards math and science may offer some important lessons for other schools and districts in the U.S.

Second, the results obtained by the FiW Consortium on this international benchmark also provide the first U.S. multi-district level data available from TIMSS. As such, they may provide valuable insights into the contexts for learning math and science in high-performing districts, and how they might relate to world class standards, not only in achievement but also in instructional, curricular, and assessment standards. Finally, the Consortium's activities offer a rare opportunity to learn from this unique cross-district, multi-partner collaborative effort to obtain world-class standards.

This report provides a status report on the FiW's initial activities. It examines five key questions:

- What is the FiW Consortium?
- How well did the FiW Consortium perform when benchmarked against an international measure of math and science achievement?
- Do home factors explain the high achievement of the FiW Consortium?
- What is the context for teaching and learning in the FiW Consortium?
- What is the FiW Consortium doing to improve math and science?

It should be noted that this report constitutes one of the first comprehensive examinations of how FiW students performed on TIMSS and an initial exploration of some of the reasons for their performance.

This paper is not based on an exhaustive review of the possible reasons for the FiW performance, but rather examines possible factors that might have had an important role. In addition, the paper does not investigate causal links between FiW achievement and the different topics discussed later.

The remainder of the report is organized into major sections, which roughly correspond to the key questions listed above.

The first section describes the districts that make up the FiW Consortium and outlines the Consortium's history, purpose, goals, and plan of action to become the first in the world in math and science.

The second section documents how the students from the FiW Consortium performed when benchmarked against an international comparison, the TIMSS assessment.

The next section discusses the impact that socio-economic variables could have on the performance of FiW students.

The fourth section presents data on the contexts for teaching and learning mathematics in the FiW, exploring differences between the FiW and the U.S. and, where data are readily available, differences between the contexts for teaching in the FiW and countries with high math achievement.

The fifth section describes some of the activities being undertaken by the FiW Consortium to improve math and science education, highlighting a recent project that is using data from TIMSS and other sources to improve science instruction.

The final section summarizes the report and offers some possible questions for future research.

What is the FiW Consortium?

This section describes the First in the World Consortium. It answers questions such as:

- How and why was the Consortium launched?
- How many students are in the Consortium?
- What are its goals?
- How does it hope to achieve these goals?

It begins with a description of the Consortium's history and origins, and then describes its goal and objectives, as well as the Consortium's plan of action for achieving these objectives.

History and Description

The FiW Consortium is currently made up of 17 school districts located in the north suburbs of Chicago and the Illinois Math and Science Academy. Together, they are pursuing a common goal of becoming first in the world in math and science achievement.

The Consortium grew out of a study group of superintendents which was formed to fulfill an administrative re-certification requirement. Members of this study group met regularly over the course of several months. Discussions at these meetings centered on contemporary education reform issues facing the administrators in their various districts.

The FiW Consortium was launched at the final meeting of the superintendents' group, during which the National Education Goals were discussed.

Determined to take the national goals seriously, the superintendents decided to form a consortium of districts committed to providing a world class education for their students. The group agreed to first focus collectively on obtaining Goal 5, to be first in the world in math and science by the year 2000.

Reflecting their goal, the group called themselves the First in the World Consortium, a title with which they felt uncomfortable, but which accurately captured their goals and aspirations. In March 1995, the Consortium entered into partnership with the U.S. Department of Education and the North Central Regional Education Laboratory in its efforts to obtain this goal.

As of winter 1999, the Consortium included 13 elementary districts (grades K–8), 3 high school districts (grades 9–12), the North Suburban Special Education District (which serves most of the districts' special education students), and the Illinois Mathematics and Science Academy (IMSA).[2] IMSA is a publicly funded educational laboratory and three-year residential secondary program for Illinois students gifted in math and science. While IMSA is a state agency, the term "districts" is used throughout the report as a convenience to the reader.

Together, these districts contain 49 elementary or middle schools, 6 high schools, and one special education school. During the 1996–97 school year, total student enrollment in these schools was

approximately 36,000 students. Nearly four out of five students (78 percent) within the Consortium were white, non-Hispanic. Fourteen percent of the students were Asian/Pacific Islanders, while seven percent were Hispanic and two percent were black, non-Hispanic.

The Consortium contains relatively high wealth districts, and thus may have different characteristics from many individual U.S. districts and the U.S. as a whole. In the 1995–96 school year, average per-pupil expenditures across the Consortium was approximately $8,958[3] compared to $5,774 in the U.S.[4]

Yet, not all of the Consortium's students come from high-income families. In 1996–97, seven percent of the Consortium's students were classified as coming from low-income families.[5] Six percent of Consortium students had limited-English proficiency (LEP).

Approximately 2,600 classroom and special education teachers teach within the Consortium.[6] In general, FiW teachers tend to have higher education levels than their U.S. counterparts: Sixty-three percent of FiW teachers have earned at least a master's degree versus 56 percent of U.S. teachers.[7] The average number of years of teaching experience for FiW teachers is 14 years.[8]

Perhaps reflecting the education and experience levels of FiW teachers, average teacher salaries in Consortium districts are relatively high. In 1995–96, the average salary for FiW elementary school teachers was $47,339. The average salary for FiW high school teachers was $65,263.[9]

U.S. teacher salaries for the same time period are lower. The average salary in the U.S. during the 1995–96 school year was $39,976 for elementary school teachers and $38,423 for secondary school teachers.[10] See appendix A for a current list of FiW districts and more information on FiW district characteristics.

Goals and Objectives

As noted earlier, the FiW Consortium decided to focus first on obtaining Goal 5 of the National Education Goals: to become first in the world in math and science. The Consortium's leadership set three objectives to help them obtain this distinction. They were:

- Benchmark Consortium schools' performance against an international measure of student achievement;
- Create a forum to clarify world-class standards for business leaders, policymakers, educators, and community members; and
- Establish networks of learning communities that actively involve educators, parents, and community leaders.

These objectives were chosen to provide Consortium leaders and educators with a baseline against which to measure their progress, as well as a better understanding and knowledge of the instructional, curricular, and assessment practices needed to obtain world-class achievement.

Recognizing that obtaining this ambitious goal would involve input, advice, and support from all members of the Consortium's community, they also sought to actively involve educators, parents, and community leaders.

Plan of Action

To obtain the consortium's goal and objectives, the FiW leadership developed and embarked upon a three-step plan of action. These steps were:

(1) developing partnerships at the national, regional, and local levels;
(2) identifying and defining world class standards in math and science; and
(3) working with the Consortium's partners to implement exemplary math and science programs.

Each of these steps is described briefly below.

First, the FiW Consortium sought to form partnerships with key organizations in the education and business communities to obtain technical, administrative, and research support in achieving its goals. Accordingly, the FiW has established working partnerships with numerous organizations, including the U.S. Department of Education, the North Central Regional Education Lab (NCREL), and policymakers at the national level, including members of Congress.

Under its agreement with the U.S. Department of Education, the Consortium committed to work with the Department to explore general outcome and specific math and science competencies in a study of global competition. It also promised to develop world class standards and align these standards with their local curricular and instructional programs and to support the acceleration of technology implementation as it pertains to math and science achievement.

In addition, the Consortium agreed to develop a math and science resource center on the World Wide Web, as well as collaborate with the Department to disseminate the Consortium's findings. It also pledged to include all students in its efforts, including students with disabilities.

The Consortium resolved to develop and implement assessment instruments to determine student achievement, and to implement staff development training to assist teachers in mastering new content and instructional strategies.

Further, the Consortium committed to entering into school and business partnerships to foster the identification of the needed skills and knowledge to achieve world class standards.

Finally, the Consortium agreed to commit the needed resources to ensure that the joint effort did not fail due to a lack of resources. Taken together, these commitments form a unique partnership between a group of local school districts and the Department of Education.

Second, the FiW leadership is working with its partners to identify and define world-class standards in the areas of math and science. As part of this effort, FiW students participated in TIMSS, the most ambitious, comprehensive, and rigorous international assessment of math and science ever undertaken. With financial support from the individual boards of education that make up the Consortium, FiW fourth, eighth, and twelfth grade students, their teachers, and their schools participated in the TIMSS study.

Although an invitation to participate in TIMSS was extended to all school districts

in the nation, the FiW Consortium was the only group that took advantage of this opportunity.

Third, FiW districts are working together to design and implement exemplary programs in mathematics and science. To achieve this goal, FiW leaders have established teacher learning networks which bring together staff from across the Consortium to identify, develop, and enact model programs in math and science instruction.

Teams are self-identified and include teachers, principals, superintendents, and other educational staff. Relying on data from TIMSS, as well as research on best instructional and curricular practices, the Consortium hopes to improve achievement by strengthening instruction, using more effective assessment tools, learning about new curricula materials and techniques, and identifying and addressing topics or areas where their students demonstrate weaknesses.

In sum, the districts that make up the FiW Consortium have sparked the attention of the education community by agreeing to work together to become first in the world in math and science. The following sections describe the efforts to enact their plan, as well as some of the their preliminary results.

In particular, the next section describes the results of the Consortium's effort to measure its performance against an international benchmark. The following two sections look at what might account for the high achievement levels obtained, exploring first the effect of socio-economic factors, and then the Consortium-wide context for teaching and learning. The subsequent section describes the Consortium's efforts to develop learning communities of educators, policymakers, and community leaders.

How Well Did the FiW Consortium Perform When Benchmarked Against an International Measure of Math and Science Achievement?

As mentioned earlier, one of the FiW Consortium's three primary goals was to benchmark its achievement against an international measure of student achievement. The FiW chose TIMSS as its measure. FiW student assessments were administered during 1996, and preliminary results were made available in January 1997. This section discusses the results of these assessments.

In general, FiW students did exceedingly well on TIMSS, particularly in the fourth and eighth grades. In the twelfth–grade advanced math and physics tests, the FiW Advanced Placement (AP) students also scored among the top performing countries. FiW students performed among the highest performing nations on the twelfth grade general knowledge achievement tests and near the international average on the advanced math and physics tests.

Fourth–, eighth–, and twelfth–grade results are discussed below and reported in more detail in appendix B.

Fourth–Grade Results

Only students in Singapore had scores significantly above those of FiW students on the fourth grade math assessment. The FiW Consortium had average scores that were not significantly different from four other countries (Korea, Japan, Hong Kong, and Netherlands). FiW students outperformed their counterparts in 21 of 26 countries.

In science, no nations outperformed fourth–grade students in the FiW. The FiW fourth grade science score was not significantly different from that of one other country (Korea). FiW students outperformed their counterparts in 25 of 26 countries. See exhibits B-1 and B-2 for more detail on scores and distributions.

Although FiW students did well on the fourth grade math test, they had stronger performance in some topic areas than in others. FiW fourth–grade math students performed among the best in the world in 8 of 14 content areas.[11] They were:

(1) integers and whole number operations;
(2) common fractions;
(3) rounding and estimating computations;
(4) geometry: position and shapes;
(5) symmetry, congruence and similarity;
(6) proportionality;
(7) patterns, relations, and functions; and
(8) data and statistics.

Topics where students from other nations scored higher were:

(1) meaning of whole numbers;
(2) decimal fractions;
(3) estimating quantity and size;
(4) measurement units;
(5) perimeter, area, and volume; and
(6) equations and formulas.

For more detail on how the FiW performed relative to other TIMSS countries, see exhibit B-3.

Eighth–Grade Results

Eighth–grade FiW students also performed very well on the TIMSS assessment compared to students from the 41 countries that participated in this part of the study. As in the fourth grade, only students in Singapore outperformed eighth–grade FiW students in math and no nations outperformed FiW students in science.

In math, only students in Singapore scored significantly above FiW students on the eighth–grade assessment. FiW had an average score that was not significantly different from six other countries (Korea, Japan, Hong Kong, Belgium-Flemish, Czech Republic, and Slovak Republic). FiW eighth–grade math students outperformed their counterparts in the remaining 34 of 41 countries.

In science, no nation outperformed FiW on the eighth–grade assessment. The FiW score was not significantly different from eight other high-performing countries (Singapore, Czech Republic, Japan, Korea, Bulgaria, Netherlands, Slovenia, and Austria). See exhibits B-4 and B-5 for more detail.

As in the fourth grade, eighth–grade math achievement varied by topic. FiW eighth–grade math students performed among the best in the world in 9 of 20 content areas.[12] They were:

(1) decimal fractions and percentages;
(2) relationships of fractions;
(3) estimations of quantity and size;
(4) rounding;
(5) estimating computations;
(6) three-dimensional geometry and transformations;
(7) patterns, relations, and functions;
(8) data representation and analysis; and
(9) statistics and probability.

Students from other nations scored higher on the following topics:

(1) whole numbers;
(2) common fractions;
(3) measurement units;
(4) perimeter, area, and volume;
(5) measurement estimations and errors;
(6) two-dimensional geometry basics;
(7) polygons and circles;
(8) congruence and similarity;
(9) proportionality concepts;
(10) proportionality problems; and
(11) equations and formulas.

See exhibit B-6 for more detail.

Twelfth–Grade Results

In the twelfth grade, two sets of assessments were administered to the countries participating in TIMSS. The first set measured student achievement in general math and science knowledge. The second was designed to measure achievement of the most advanced students in their final year of secondary school. Accordingly, the advanced math exam covered advanced math topics, including geometry, numbers and equations, and calculus. The advanced exam in science focused on physics.

In the United States, the advanced math assessment was given to students who had taken, or were taking, a full year of a high school course that included calculus in the title, including calculus, pre-calculus, AP Calculus, and calculus and analytic geometry.

Using the U.S. definition for advanced math, approximately 14 percent of the U.S. school-

leaving age cohort was covered by the TIMSS sample of advanced math students. Internationally, 19 percent of the school-leaving age cohort was covered, under the various definitions used by different countries to identify their most advanced students.

By comparison, the FiW advanced math sample covered approximately 65 percent of the FiW school-leaving age cohort under the same definition used by the U.S., clearly a much larger percentage of students than the U.S. or its international peers.[13]

To take the physics assessment, U.S. students had to be enrolled in, or have taken at least one year-long class of physics (this includes physics and AP Physics). Under this definition, approximately 15 percent of the U.S. school-leaving age cohort was covered by the TIMSS sample of physics students. Internationally, approximately 13 percent of the school-leaving age cohort were covered by this assessment using the different definitions of eligibility developed across countries.

As with mathematics, a much larger percentage of FiW twelfth–grade students were exposed to physics than U.S. or international students. In the FiW, approximately 67 percent of the school-leaving age cohort were covered by the physics sample.[14]

The large difference between the percent of the school-leaving age cohort covered in the U.S. and FiW samples is explained primarily by differences in course taking patterns, rather than differences in the number of students in this age cohort who are still in school or differences in which components of the system they may have excluded from their sample.

Eighty-three percent of FiW students take mathematics and 74 percent take science in their last year of schooling. In the U.S., however, less than two-thirds of all seniors enroll in a math class and less than one-half of U.S. seniors take a science class.

Furthermore, nearly all FiW students take at least one of the following classes: pre-calculus, calculus, AP Calculus, physics, or AP Physics.[15] Results for each set of exams are discussed below.

General Knowledge

In general mathematics knowledge, FiW twelfth grade students' performance was not significantly different from students in the seven highest performing countries (Netherlands, Sweden, Denmark, Switzerland, Iceland, Norway, and Australia).

FiW students outperformed their counterparts in the remaining 14 countries. It should be noted that no Asian countries participated in the end of secondary school assessments. See exhibit B-7 for more detail on the countries participating in this assessment and the distribution of their scores.

In general science knowledge, the achievement of FiW twelfth–graders was similar to their achievement in mathematics. FiW twelfth–grade students' performance on general science knowledge was not significantly different from students in the seven highest performing countries (Sweden, Netherlands, Iceland, Norway, Canada, New Zealand, and Australia). FiW students outperformed their counterparts in the remaining 14 countries. See exhibit B-8 for more detail.

Advanced Math and Physics

The TIMSS advanced math and physics exams were designed to be administered to the highest performing students in the world in math and science as they are about to leave secondary school. Each country defined the groups of students that they thought most appropriate to be included in these assessments, based on the general content of the tests as well as practical considerations.

In order to have large enough samples of students taking the advanced math and science exams, the U.S. included pre-calculus and general physics students in the advanced groups. Other countries limited their testing to calculus and advanced physics students.

The Consortium followed the U.S. sampling parameters, even though it had a large proportion of students who would qualify under the more restrictive international criteria, as discussed below. We have, therefore, presented two different views of the advanced math and physics test data.

In advanced mathematics, for example, we present the FiW Advanced Placement Calculus student score on the advanced examination to provide comparison with other countries. We also provide the score for all students who took the advanced test for comparison to the U.S. national score.

As discussed in the rest of the section, the Consortium's AP Calculus and AP Physics students were first in the world. However, when the pre-calculus and general physics students are incorporated into the FiW scores, the FiW averages drop below the international average. The section considers the general results first, then provides the results for the AP Calculus and AP Physics students.

On the advanced math assessment, FiW students scored near the international average. Advanced FiW twelfth–grade math students were outperformed by students in seven countries (France, Russian Federation, Switzerland, Denmark, Cyprus, Lithuania, and Sweden). FiW scores were not significantly different from those of six countries. FiW placed significantly above three countries. See exhibit B-9 for more detail.

FiW physics students were significantly below students in twelve nations (Norway, Sweden, Russian Federation, Denmark, Slovenia, Germany, Australia, Cyprus, Switzerland, Greece, Canada, and France). FiW performance did not differ significantly from three nations, outperforming only the United States in the TIMSS physics assessment. See exhibit B-10 for more detail.

AP Calculus and AP Physics Results

Many have wondered whether it was appropriate to be comparing two-thirds of the students in FiW against one-fifth or fewer students in the U.S. or internationally because such large percentages of FiW twelfth grade students were included in the advanced math and science samples. It has been suggested that AP Calculus or AP Physics students might make a better comparison group for the advanced math and science assessments because these students are enrolled in the most advanced courses and similar percentages of FiW and international students would be covered under such a comparison.

AP courses are offered in all FiW high schools and are generally considered to be the most advanced classes offered in mathematics or physics, since students participate in national AP exams and may receive college credit if they score well on these exams. FiW AP Calculus students represent 28 percent of the FiW school-leaving population. Under this comparison, then, 28 percent of the FiW students are being compared against 19 percent of international students and 14 percent of their U.S. counterparts.

In AP Physics, 7 percent of the FiW school-leaving cohort is compared against 13 percent internationally and 15 percent of U.S. students.[16]

FiW twelfth–grade AP Calculus students were first in the world, as no nations outperformed FiW AP Calculus students on the advanced math assessment. The FiW score was significantly above that of sixteen nations. See exhibit B-11 for more detail.

Performance of AP Physics students in FiW Consortium was also first in the world. No nations scored significantly above FiW AP Physics students. Five nations (Norway, Sweden, Russian Federation, Slovenia, and Germany) had scores that were not significantly different from FiW AP Physics students. FiW AP Physics students outperformed their counterparts in 11 countries. See exhibit B-12 for more detail.

Summary

When benchmarked against an international measure of math and science achievement, FiW students performed exceptionally well in all grades tested.

FiW students excelled on the fourth, eighth, and twelfth grade general knowledge tests, and scored among, or just below, the highest performing countries worldwide. Although all Consortium students tested on the advanced math and physics tests did not perform as well as expected (they scored around the international average), the performance of AP students was exceedingly high, with their scores placing them in first place internationally.

The outstanding performance of the FiW students, particularly given the disappointing results of their U.S. counterparts, has generated a lot of interest in examining what factors might have contributed to this world-class performance.

The next two sections look at the influence that home factors and differences in the contexts for teaching and learning might have on these gaps.

Do Home Factors Explain the High Achievement of the FiW Consortium?

As mentioned earlier, the districts that make up the FiW Consortium are high wealth districts. The question that natuarlly arises is: Could student and family background characteristics explain the differences in achievement between the FiW Consortium and the U.S.?

To examine this question, an exploratory analysis was conducted using TIMSS achievement and student and family characteristics data.[17] The analysis identified a set of student and family variables included in the TIMSS' questionnaires that were found to be highly correlated with student math achievement. These variables included parents' education level, whether the student's parents were born in the U.S., language spoken at home, and number of books in the home.

A set of regression analyses were run to estimate the difference between the FiW and U.S. scores not attributable to home and family characteristics (in scale points) for the fourth and eighth grades in math and science, and the twelfth grade for general knowledge of math and science.

These exploratory analyses showed that the point differences between the FiW and U.S. students' scores could not be fully attributed to students' home and family characteristics.

In fourth–grade math and eighth–grade math and science, socio-economic factors explained approximately 20 to 25 percent of the difference in scale scores, but left 75 to 80 percent unexplained.

Family and parental characteristics could account for slightly more of the difference in eighth–grade science, and twelfth–grade math and science. In these cases, half of the difference is attributable to family and home factors.

There are, however, some immeasurable effects of resource rich districts that may not be well measured by this analysis—a more stable teaching force, high levels of involvement from parents, and high expectations for students.

These factors may play as important a role as that of high financial resource levels in promoting high achievement. In fact, some believe that one of the explanations for the high achievement levels in FiW districts is how they use their wealth to support teaching and learning, not the wealth itself.

While further analysis may give more precise estimates of the relationship between achievement and socio-economic status in the FiW Consortium, this analysis and results from other preliminary analyses[18] indicate that other factors, such as curriculum, classroom instructional practices, and teacher engagement, play an important role in their high achievement levels.

The next section explores some of the other factors that may have contributed to the Consortium's success.

What is the Context for Teaching and Learning Math in the FiW Consortium?

This section offers some possible explanations that might account for the differences in math achievement between the FiW and the U.S. that cannot be attributed to home factors.

Drawing on data from the TIMSS teacher surveys, an analysis of textbooks done by researchers at Michigan State University, and anecdotal information based on visits to FiW schools, this section discusses differences in the contexts for teaching and learning between the FiW Consortium and the U.S.

Where international data are readily available, comparisons are also made between the contexts for teaching and learning in the FiW and those in countries with high math achievement to point out similarities or differences where they exist.

In order to simplify the analysis, the section concentrates only on the differences in the contexts for learning math. An examination of differences in the contexts for learning science may show different results.

In addition, the section only looks at the contexts for learning math in the fourth and eighth grades. These grades were selected because of the rich data available from TIMSS for analyzing math instruction at these levels.[19]

The findings presented in this section should be viewed as an exploration of some possible reasons for the high achievement in the FiW Consortium. This report is a first attempt to identify factors that may play an important role.

Further analysis may reveal other factors that might explain the differences in achievement between the FiW and the U.S. In addition, the paper does not investigate possible causal links between the factors discussed and the achievement gaps.

Finally, because of data limitations, this paper points only to interesting differences in patterns between the contexts for learning in the FiW, U.S. and, when data are available, other high performing countries.[20]

Drawing on data from TIMSS, this section looks at differences in four key areas that are commonly thought to have a large impact on achievement levels:

- *Curriculum.* In particular, differences in instructional topic coverage and the coverage of different topics by textbooks are explored.
- *Classroom instructional practices.* The report looks at both student and teacher reports on the most frequently used class activities and classroom organizational methods.
- *Teacher engagement.* Four factors are examined: the time spent by teachers on school-related activities during personal time, frequency of teacher meetings, teacher influence over key school decisions, and teacher familiarity with key curricular and assessment documents.
- *Teaching environment.* Finally, teacher reports on the factors that limit their teaching ability are compared.

Each of these areas is discussed in more detail in the next section.

Curriculum

It is a common sense conclusion that what is taught in classrooms around the world has an impact on what is learned. Accordingly, differences in the math curriculum covered in the FiW and the U.S. may account for some of the variations in achievement between the FiW and U.S. students.

In particular, differences in the organization and sequence of topics, the level and depth of coverage, and the timing of topic introduction may reflect important differences in the opportunities for FiW and U.S. students to master math and science material.

The textbooks and other curricular materials used may also play a potentially important role, if they are found to be more closely aligned with the curriculum of high achievement nations. This section presents data on teacher reports on instructional topic coverage and textbook content and use.

Instructional Topic Coverage

One of the first insights from the TIMSS data has been the lack of rigor in the U.S. math curriculum. Many educational researchers and policymakers have expressed concern that U.S. students are not being taught the concepts and skills needed to achieve world class standards.

Accordingly, one possible explanation for differences in math achievement between the FiW and the U.S. might be variations in instructional topic coverage, i.e., what content teachers cover in class.

Differences in both the number and type of math topics covered throughout the school year may indicate that fourth–and eighth–grade FiW students are exposed to more advanced material than their U.S. counterparts.

According to TIMSS data, FiW students are more likely than their U.S. peers to be introduced to relatively more advanced math topics in earlier grades. This pattern is reflected in data reported by math teachers in the fourth and eighth grade.

Exhibit 1 presents detailed data on instructional topic coverage for 21 math topics in fourth-grade math.[21] In a number of key subject areas, all or nearly all FiW and U.S. students are introduced to these subjects by the end of the fourth grade, according to their math teachers.

Some of these students cover these topics in their entirety in earlier grades (indicated on the exhibit as "learned earlier"), others begin topics in earlier grades and receive reinforcement on the material during fourth grade (indicated as "reinforced information"), while still others are first introduced to the material in fourth grade (indicated as "new information").

In topic areas where these three categories sum to 100, teachers report that all fourth grade math students will have been introduced to these subjects prior to, or during, the current year.

All, or nearly all, FiW and U.S. fourth grade math students are introduced to the following five basic concepts prior to, or during, fourth grade, according to teacher reports (that is, the percentage of students in "learned earlier", "reinforced information"

and "new information" sum to 100 or near 100):

(1) whole numbers;
(2) common and decimal fractions;
(3) estimation and number sense;
(4) measurement units and processes; and
(5) data representation and statistics.

In all of these subjects, FiW students were more likely to have been exposed to the topic earlier than their U.S. counterparts. For example, 75 percent of FiW students had either learned whole numbers prior to fourth grade (e.g., covered it in grade three or earlier and were no longer spending time on this concept) or were receiving reinforcement.

In contrast, less than half of U.S. students (43 percent) had been exposed to this material earlier, according to their teachers.

FiW students are also more likely than their U.S. fourth–grade counterparts to be introduced to two more difficult math concepts during or prior to fourth grade:

(1) percentages, and
(2) number sets and concepts.

Seventy-seven percent of FiW students have been introduced to percentages prior to or during fourth grade (calculated by adding the three categories indicating when topics are introduced: e.g. "learned earlier" + "reinforced information" + "new information").

This compares to only 47 percent of their U.S. peers. Sixty-three percent of FiW students have been introduced to number sets and concepts prior to or during fourth grade, compared to only 32 percent of their U.S. peers.

As illustrated in exhibit 2, according to teacher reports, all or nearly all eighth grade FiW and U.S. students had been introduced to the following eleven math topics:[22]

(1) whole numbers;
(2) common and decimal fractions;
(3) percentages;
(4) number sets and concepts;
(5) number theory;
(6) estimation and number sense;
(7) measurement units and processes;
(8) perimeter, area, and volume;
(9) basics of one- and two- dimensional geometry;
(10) ratio and proportion; and
(11) equations, inequalities and formulas.

However, as in the fourth grade, FiW students are more likely than their U.S. counterparts to have been exposed to most of these basic math concepts in preceding grades. As a result, FiW students are more likely to either not cover these topics again in the eighth grade or spend time reinforcing these concepts.

For example, according to their teachers, eighth–grade FiW math students were much more likely than their U.S. counterparts to have covered whole number operations and meaning in earlier grades and moved beyond this material. Forty percent of FiW students covered this material in earlier grades; while only 16 percent of U.S. students covered this material earlier and were not covering it in eighth grade according to their teachers.

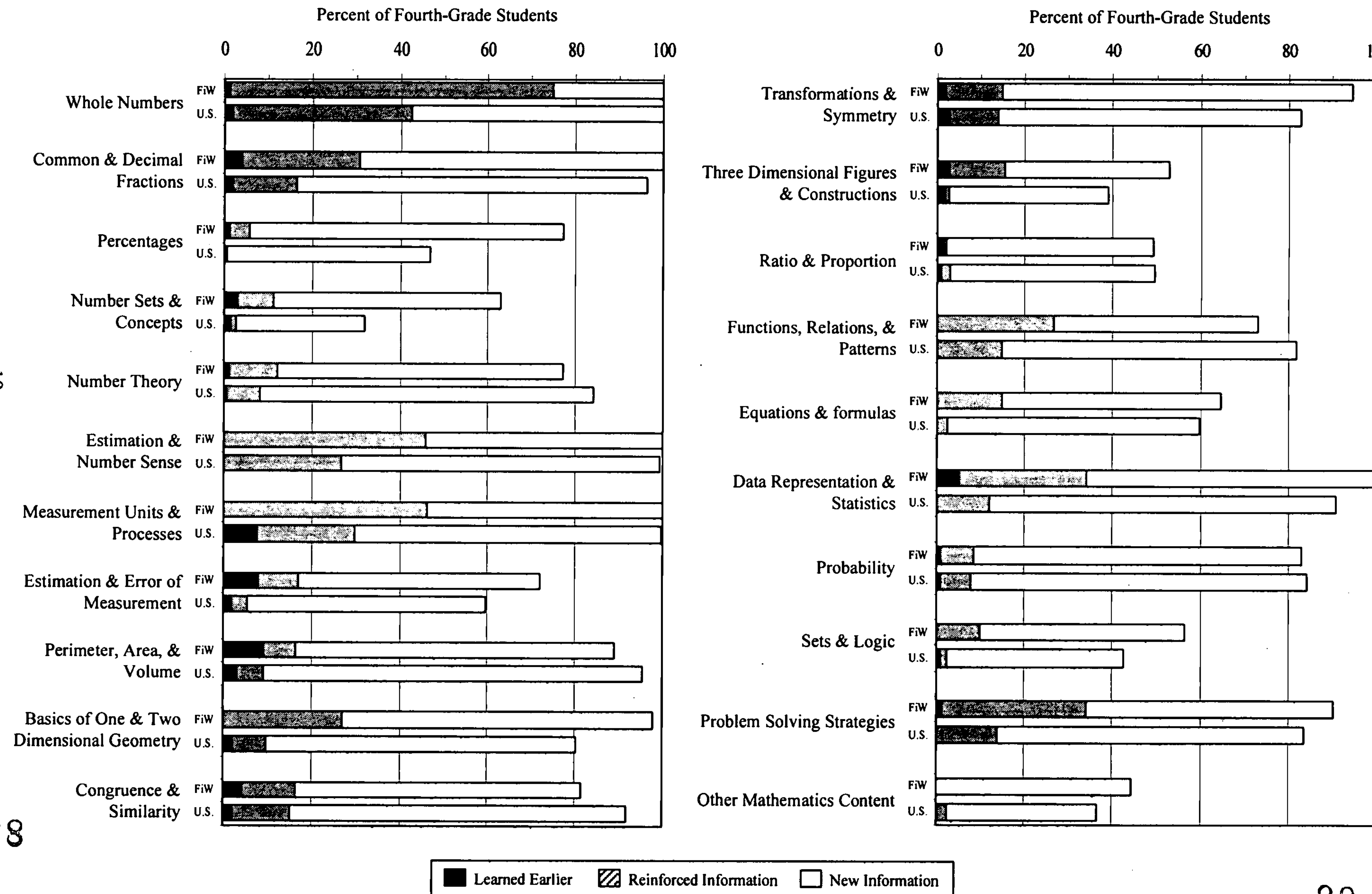
For the other ten subjects, FiW students were much more likely than U.S. students to have been exposed to the material in prior grades and to spend time in their eighth grade math classes reinforcing this material.

Eighth–grade students in the FiW were also more likely than their U.S. counterparts to have been introduced to new, more advanced material during the eighth grade. The more advanced material includes:

(1) geometric congruence and similarity;
(2) geometric transformations and symmetry;
(3) constructions and three-dimensional geometry;
(4) proportionality: slope, trigonometry, and interpolation;
(5) functions, relations and patterns; and
(6) sets and logic.

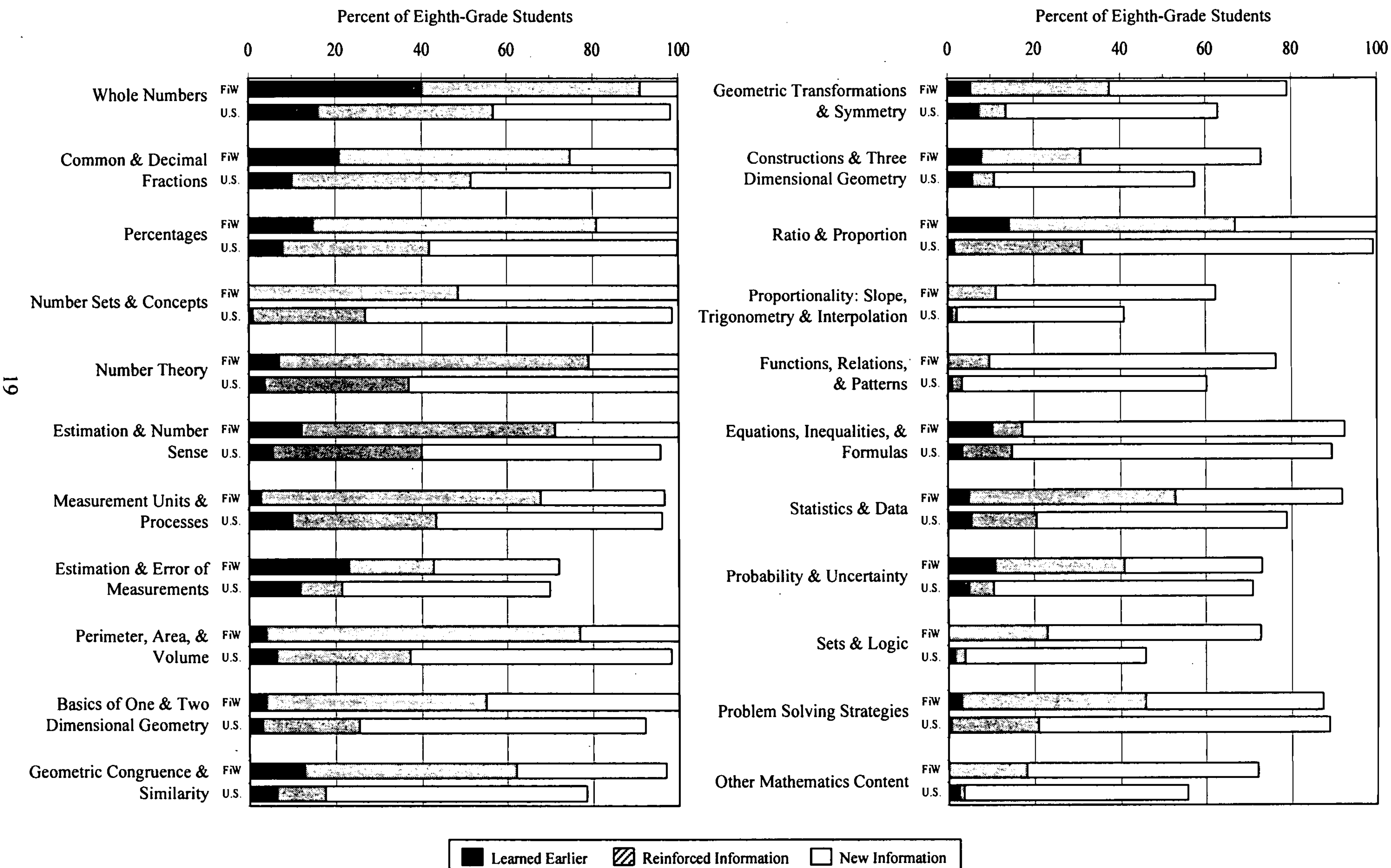
While the data on instructional coverage give us some clues as to when FiW and U.S. fourth–and eighth–graders are introduced to different topics, the data do not provide much insight into the level or depth of coverage. Further research in this area could potentially give a fuller understanding of the differences in implemented curriculum between the FiW and the U.S.

Exhibit 1: Fourth-Grade Math Teachers' Reports on Instructional Topic Coverage



SOURCE: NCREL Analysis of Teacher Questionnaire Data.

Exhibit 2: Eighth-Grade Math Teachers' Reports on Instructional Topic Coverage



SOURCE: NCREL Analysis of Teacher Questionnaire Data.

Textbook Use and Topic Coverage

Could the difference in achievement be influenced by variations in the way textbooks are used in the classroom or the textbooks chosen? This section looks at TIMSS questionnaire data and a special study commissioned by FiW to examine the degree to which teachers rely on their textbooks to structure their teaching time, as well as the types of topics covered in these textbooks and the relative emphasis given to each topic.

TIMSS teacher questionnaires indicate that nearly all students use a textbook in FiW and U.S. eighth–grade math classes (100 percent of FiW students and 97 percent of U.S. students). The degree to which eighth grade math teachers use these books to structure their teaching time varies considerably, however, according to teacher reports. FiW students are more likely than U.S. students to be in classes where a large percentage of the teaching time is based on material in the text. As seen in exhibit 3, 55 percent of eighth–grade students are in classes where more than three-fourths of the teaching time is based on material in the textbook. In contrast, only 36 percent of U.S. students are in classes that rely this heavily on material in the textbook.

FiW teachers also report using a considerable amount of supplementary material in addition to their main textbook. As shown in exhibit 3, 91 percent of FiW and all U.S. students have teachers who use other materials in the place of or in addition to their main textbook. In both cases, textbooks appear to be used as one resource out of many rather than the sole resource.

Exhibit 3: Teachers' Reports on Use of Textbooks and Other Teaching Materials and Percent of Mathematics Teaching Time Based on Textbook

Textbook Use	**Percent of Eighth–Grade Students**	
	FiW	U.S.
Use a textbook at all	100	97
Use supplementary materials	91	100
Percent of teaching time based on textbook		
1–25 percent	6	16
26–50 percent	4	17
51–75 percent	35	31
76–100 percent	55	36

SOURCE: NCREL analysis of TIMSS Data; FiW Teacher Questionnaire results.

Data from the TIMSS curriculum study done by researchers at Michigan State University catalogued the topics covered by different textbooks and the relative emphasis given to each topic. Their analysis of math textbooks used by the FiW, U.S. and TIMSS[23] countries report the following conclusions:

- "The number of topics in Consortium textbooks is similar to that in textbooks of the US composite at all populations. [grade levels]. "[24]

Fourth Grade

- At the fourth–grade level, "the consortium's textbooks are essentially no different in their content profiles from the US as a whole and [they also have] a great deal of overlap in content with Japan."
- The major exception is "the prominent presence of decimals in the Japanese textbooks, which is not the case in U.S. or FiW textbooks."[25]

Eighth Grade

- "At the eighth–grade level, there are notable differences in the topics emphasized in the Consortium...with the topic of 'Equations and Formulas' for example, more emphasized in the Consortium than is the case for the most commonly used textbooks in the U.S."[26]
- "The emphasis of Consortium textbooks on 'Equations and Formulas' in Grade 8 is similar to that of TIMSS countries in which mean student achievement was significantly higher than mean student achievement in the U.S."[27]
- "This greater focus and emphasis on algebra is further reflected by the fact that the Consortium's books for the non-algebra tracks do not have any of the standard arithmetic topics among the top 5 contained in the book. This is in marked contrast to U.S. non-algebra books."
- "The Consortium teachers clearly emphasize algebra (linear equations) and geometry (2D geometry basics) more than is common for their U.S. peers, an emphasis that appears to be aided by the fact that the textbooks themselves provide more material in these areas."[28]

In sum, some differences in curriculum may contribute to the differences in achievement between the FiW and the U.S. At both grade levels, these differences do not seem to be driven by differences in the number of topics found in textbooks used by FiW and U.S. students, as the number of topics covered by FiW math textbooks is very similar to the number covered by other U.S. math textbooks.

However, FiW eighth–grade textbooks tend to emphasize algebra and geometry more heavily, while U.S. textbooks emphasize arithmetic. This is true even for the students in the non-algebra tracks. In addition, at the eighth–grade level, a higher percentage of FiW students than U.S. students are likely to be in classrooms where most of the teaching time is centered on material in the book.

However, there is some anecdotal information that indicates FiW teachers are more apt to customize the textbooks used, e.g. carefully selecting chapters and exercises to be completed. This might be in contrast to the typical use of textbooks and

could be an important component in understanding how FiW teachers can use textbooks with a large number of topics effectively.

Summary

Differences in achievement do not appear to be driven by the number of topics covered in the classroom or in the textbooks. According to teacher reports, FiW students seem to cover just as many topics as their U.S. peers. Likewise, FiW textbooks cover the same number of topics as U.S. textbooks.

However, FiW eighth graders are more likely than their U.S. peers to use textbooks that emphasize algebra and geometry. In addition, FiW students may be introduced to more advanced topics earlier than their U.S. peers.

Additional analysis is necessary to determine whether more advanced concepts are actually covered or just presented in a simplistic way.

Nevertheless, according to teacher reports, FiW students receive more reinforcement of topics introduced in earlier grades and cover more new material.

This pattern is found in both the fourth–and eighth–grades, and as might be expected, is more pronounced in the eighth grade.

The next section explores whether there are notable differences between the instructional strategies used by FiW and U.S. teachers that may also contribute to the differences in achievement.

Classroom Instructional Practices

There is a rich research base regarding what happens in most classrooms in the U.S. While much of the literature documents established patterns of teacher-student interactions, some studies have examined the relationship between classroom instructional practices and student achievement. The indicators selected for analysis in this section are based on that literature and some of the unique practices in FiW districts.

As discussed in the following three sections, data from the TIMSS teacher and student surveys suggest that some of the explanation for the differences in achievement may be due to differences between the methods that FiW and U.S. teachers use to present material to their students.

In particular, data on teachers' reports on class activities and classroom organization, as well as students' reports on the same, indicate that notable differences may exist between the FiW and the U.S. in the context for learning in student classrooms.

Teachers' Reports on Class Activities

Differences in classroom activities, that is, the actual tasks that teachers require their students to do in class, may account for some of the variations in achievement.

For example, some teachers may ask their students to tackle more challenging tasks or complex math problems that require students to apply their skills to different problems. Other teachers may challenge students to explain the reasoning behind new concepts more frequently.

Some students may spend more time using computers to apply new math concepts to solve exercises or problems. Other students may spend their time completing less challenging tasks, like completing drills or practicing basic computational skills.

This section explores whether differences exist between the types of activities used frequently in the FiW and U.S. math classes.

Data on the types of activities that teachers report they ask their students to do in class indicate that important differences may exist between the classroom activities in FiW and U.S. classes. However, the data also show many similarities. Both the differences and similarities are discussed below.

According to teachers, FiW math students in both the fourth and eighth grades are asked to perform reasoning tasks more frequently and complete drills less frequently than U.S. students.

As shown in exhibit 4, FiW students are more likely than U.S. students to have math teachers who ask them to explain the reasoning behind an idea during "every lesson." Thirty percent of FiW fourth–grade students have math teachers who ask them to explain their reasoning during "every lesson," 21 percent of U.S. fourth graders fall into this category.

At the eighth–grade level, the difference is more pronounced: 48 percent of FiW students have teachers who ask their students to explain the reasoning behind an idea during "every lesson," while roughly half as many (23 percent) of U.S. students have teachers that do.

FiW students are also more likely than U.S. students to be asked by their teachers to write equations during "most lessons" or "every lesson." In eighth grade, three fourths of FiW students have math teachers who ask their students to write equations during "most lessons" or "every lesson."

The percentage of U.S. students being asked to express relationships in equations in "most lessons" or "every class" is far lower—only 38 percent of eighth–graders.

While the difference between FiW and U.S. eighth–grade students may be a function of the higher percent of FiW students taking algebra classes, the difference is notable.

In the fourth grade, FiW and U.S. students are asked to use equations to express relationships less frequently, however FiW students are more likely than their U.S. counterparts to be asked to write equations (94 percent of FiW students, 83 percent of U.S. students).

Most fourth–and eighth–grade students, in both the FiW and the U.S., are only asked to undertake more complex or challenging activities—such as representing and analyzing relationships using tables, charts, or graphs or working on problems for which there is no immediate solution—during "some lessons."

Roughly 80 percent of FiW and U.S. fourth–grade math students and 70 percent of FiW and U.S. eighth grade students spend time during "some lessons" representing and analyzing relationships using tables, charts, or graphs.

In both the fourth and eighth grades, teachers reported roughly 65 percent of FiW and U.S. students are asked by their teachers to work on problems for which there is no immediate solution during "some lessons."

According to teacher reports, FiW students also practice computational skills in class less frequently than their U.S. counterparts. Teachers report that 58 percent of FiW fourth graders practice their computation skills during "most lessons" or "every lesson" compared to 70 percent of their U.S. counterparts.

In the eighth grade, students in both FiW schools and schools across the U.S. are less likely to practice computational skills frequently. However, the difference between the FiW and the U.S. eighth graders is even more striking: 25 percent of FiW math students practice computational skills during "most lessons" or "every lesson", compared to 59 percent of U.S. students.

The differences between how often FiW and U.S. students are asked to practice computational skills could be a function of higher expectations of mastery in earlier grades without the need for teaching and re-teaching the same topics year after year.

Classroom computer usage is another area where notable differences exist between FiW and the U.S. Neither FiW nor U.S. students use computers routinely to solve exercises or problems. However, in both the fourth–and eighth–grades, FiW teachers report that over half of the students use computers during "some lessons," while only a little over one-third of U.S. fourth–graders, and less than a quarter (21 percent) of U.S. eighth–graders, use computers.

While these data point out interesting contrasts, the differences in computer use may be a function of the availability of technology. A further look needs to be taken at how computers are actually used in FiW classrooms, as compared to the U.S.

Finally, one additional key point that can be made after reviewing exhibit 4 is the pattern, or lack of pattern, that emerges in FiW and U.S. classrooms.

It is interesting to note that the most predominant activities in FiW fourth grade classrooms—explaining the reasoning behind an idea, practicing computational skills, and writing equations—are consistent with the U.S. patterns.

At the eighth–grade level, however, there is a striking difference between FiW and U.S. reports in the areas of writing equations and practicing computational skills.

Taken together, these data suggest that FiW and U.S. teachers ask their students to do similar things in their math classes. However, there are a number of noteworthy differences.

In general, FiW students are challenged to perform reasoning tasks more frequently and complete drills less often than their U.S. peers. As noted above, the differences are particularly evident at the eighth–grade level, where FiW students are more frequently required to write equations, rather than practice their computational skills.

One could reasonably conclude that students in FiW eighth–grade classrooms are experiencing very different content and instruction from students in U.S. classrooms.

Exhibit 4: Teachers' Reports on How Frequently Students Are Asked to Complete Specific Tasks

Response		Percent of Fourth-Grade Students		Percent of Eighth-Grade Students	
		FiW	U.S.	FiW	U.S.
Explain the reasoning behind an idea	Every lesson	30	21	48	23
	Most lessons	56	50	28	44
	Some lessons	14	28	24	32
	Never or almost never	0	1	0	1
Represent and analyze relationships using tables, charts, or graphs	Every lesson	0	1	0	2
	Most lessons	5	7	21	10
	Some lessons	86	81	72	73
	Never or almost never	9	10	7	15
Work on problems for which there is no immediate…solution	Every lesson	1	1	0	2
	Most lessons	12	6	17	10
	Some lessons	64	59	68	65
	Never or almost never	22	35	14	24
Use computers to solve exercises or problems	Every lesson	0	1	0	2
	Most lessons	1	1	0	2
	Some lessons	64	39	56	21
	Never or almost never	36	60	44	76
Write equations to represent relationships	Every lesson	4	6	23	6
	Most lessons	25	22	54	32
	Some lessons	65	55	23	58
	Never or almost never	5	18	0	5
Practice computational skills	Every lesson	20	24	7	21
	Most lessons	38	46	18	38
	Some lessons	40	29	56	31
	Never or almost never	2	1	18	11

SOURCE: NCREL analysis of IEA's Third International Mathematics and Science Study (TIMSS) data 1994–95; FiW Teacher Questionnaire results, NCREL; tables 5.10 and 5.17 in Mullis, I.V.S., *et al.* (1997). *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College; tables 5.10 and 5.17 in Beaton, A.E., *et al.* (1996). *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

NOTE: Totals may not add to 100 due to rounding.

Teachers' Reports on Classroom Organization

The different methods that math teachers employ to organize their classrooms and the different pedagogical approaches they use may have an impact on the achievement of their students.

In particular, the amount of time teachers spend standing up in front of their class introducing new material, explaining new concepts, and answering student questions, as opposed to having students work through exercises on their own, may play an important role in explaining the differences in achievement between FiW and U.S. students.

Similarly, whether students work together as a class or break off into small groups may affect student achievement. Furthermore, the choice of organizational or pedagogical approach that may have the strongest impact on the achievement of younger students may be different than the most effective choice for older students.

Accordingly, this section examines TIMSS teacher data on classroom organization for any differences in patterns between the FiW and the U.S. for both fourth–and eighth–graders.

Teachers' reports on classroom organization show some differences between the FiW and the U.S., and some similarities between FiW and countries with high math achievement.

As shown in exhibit 5, FiW fourth grade math teachers reported that FiW students are less likely than their counterparts in both the U.S. and high performing countries to be taught by teachers that rely either heavily or predominantly on any one classroom organizational approach.

In fact, the method that is the most heavily relied upon for teaching FiW fourth–grade math students—students working together as a class with their math teacher leading the whole class—is used during "most or every lesson" for less than half of fourth–grade FiW students.

FiW fourth graders are considerably less likely than both U.S. students and their counterparts in Japan, Korea, and Singapore to spend "most or every lesson" working individually with assistance from their math teacher, according to teacher reports.

This is the one area where there are notable differences between FiW and the U.S.: twenty–four percent of FiW students are asked to take this approach, compared to 55 percent of U.S. students, according to their teachers.

In the eighth grade, classroom organizational patterns are different from those in the fourth grade. FiW teachers reported that three quarters of their students work together as a class with the math teacher teaching the whole class during "most or every lesson."

The strong emphasis on whole class instruction was also reported in other countries with high achievement. According to teacher reports, over 60 percent of eighth grade math students in Singapore, Korea, and Japan spend "most or every lesson" working together with the math teacher teaching the whole class.

By contrast, less than half of eighth–grade math students in the U.S. spend "most or every lesson" receiving instruction in large groups. U.S. teachers also report that half of

eighth–graders spend "most or every lesson" working individually with assistance from teachers.

This is a much higher percentage than in the FiW Consortium, where only 35 percent are in classes where this technique is used as frequently.

To summarize, TIMSS teacher data suggest the existence of important differences between FiW and U.S. and similarities between the FiW and high math achievement countries in the context for teaching math.

According to these data, fourth–grade FiW students are more likely than both their U.S. and international peers to be taught by multiple methods of instruction.

FiW eighth–graders, however, spend more time receiving whole class instruction—in this case, the pattern is similar to their international peers but differs considerably from that found in the U.S.

Again, one might conclude that the FiW students are being exposed to more new content in the eighth grade than U.S. students and that higher expectations are imposed on them to learn more complex mathematics.

Exhibit 5: Teachers' Reports on Classroom Organization During Mathematics Lessons

Country	Percent of Students Whose Teachers Report Using Each Organizational Approach "Most or Every Lesson"					
	Work Together as a Class with Students Responding to One Another	Work Together as Class with Teacher Teaching the Whole Class	Work Individually with Assistance from Teacher	Work Individually without Assistance from Teacher	Work in Pairs or Small Groups with Assistance from Teacher	Work in Pairs or Small Groups without Assistance from Teacher
*Fourth Grade **						
FiW	37	48	24	26	36	23
United States	32	54	55	15	20	11
Korea	50	77	57	37	30	20
Japan	50	78	34	25	7	2
Singapore	23	68	37	41	25	10
*Eighth Grade **						
FiW	42	75	35	22	20	16
United States	22	49	50	19	26	12
Korea	39	89	41	30	12	11
Japan	22	78	27	15	7	1
Singapore	15	61	48	27	20	6

SOURCE: FiW Teacher Questionnaire results, NCREL; figure 5.5 in Mullis, I.V.S., *et al.* (1997). *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College; figure 5.3 in Beaton, A.E., *et al.* (1996). *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

* Fourth/eighth grade in most countries.

Students' Reports on Classroom Organization and Class Activities

TIMSS also collected data from students on what happens in the classroom. As in the teacher questionnaires, the student questionnaires asked students to report on how frequently different classroom organization methods were used and how often varying class activities were undertaken

This section looks at FiW and U.S. student reports on what happens in their math classrooms in order to get a fuller understanding of the varying classroom organizational and activity patterns commonly used, as well as some insight into the differences between teachers' and students' reports.

FiW and U.S. students' reports on classroom organization and class activities provide an interesting picture of the similarities between what goes on in FiW and U.S. math classes. Exhibit 6 presents data on students' reports on the frequency of math class activities. As shown in the exhibit, fourth– and eighth– grade students in FiW and U.S. schools report similar patterns for the four most frequently emphasized activities in their math classes.

These activities are:

(1) teacher demonstrations of how to do math problems;
(2) distribution of homework;
(3) teacher checking of homework (fourth grade)/class discussions of completed homework (eighth grade); and
(4) students working from worksheets or textbooks on their own.

The majority of students in both the FiW and the U.S. report that they perform these activities during "most lessons."

Although important similarities emerge, students also reported differences between the FiW and U.S., and between the fourth and eighth grades.

The relative importance placed on two common activities, copying notes from the board and taking quizzes or tests, illustrates some of these differences. In the fourth grade, 32 percent of U.S. students reported that they copy notes from the board during "most lessons" compared to 22 percent of FiW students.

In the eighth grade, this technique is relied upon more frequently than in fourth–grade classrooms, in both FiW and U.S. math classes. Interestingly, unlike in the fourth grade, eighth–grade FiW math students are more likely than their U.S. counterparts to report that they copy notes from the board during "most lessons" (47 percent of FiW students versus 42 percent of U.S. students).

As for taking quizzes or tests, differences also exist between the FiW and the U.S. in both the fourth and eighth grades. In the fourth grade, U.S. students are more likely than FiW students to report that they are tested during "most lessons" (48 percent of U.S. students compared to 32 percent of FiW students).

In the eighth grade, however, FiW students reported that they are more likely to be tested during "most lessons" than their U.S. counterparts (46 percent of FiW students compared to 39 percent of U.S. students).

FiW fourth–grade math students reported that they used calculators more frequently than their U.S. counterparts, however, most

FiW students (75 percent) reported that calculators were only used during "some lessons." For the U.S., 46 percent of students reported that calculators are used during "some lessons," while almost four out of ten U.S. students (39 percent) reported that they are never used.

Calculator usage was reported more frequently in the eighth grade than in the fourth grade by both FiW and U.S. students, although the gap between FiW and the U.S. remains. Sixty-nine percent of eighth–grade FiW students reported that calculators were used during "most lessons," while only 38 percent of U.S. students reported that calculators were used "most lessons." This could either be a resource issue, (i.e. availability of calculators), or a function of the content and topic coverage in math classrooms.

Other differences between the FiW and the U.S. exist in how homework is assigned and used. In both the fourth and eighth grades, FiW students are more likely than U.S. students to report that they have homework assigned regularly.

In the fourth grade, approximately three-fourths of FiW students, versus two-thirds of U.S. students, report that their math teacher gives them homework during "most lessons." They are also more likely than their U.S. counterparts to be able to start their homework in class during "most lessons" or "some lessons" (83 percent of FiW fourth–graders versus 69 percent of U.S. fourth–graders) and to discuss their completed homework in class during "most lessons" or "some lessons" (87 percent of FiW fourth–graders versus 72 percent of U.S. fourth–graders).

In the eighth grade, differences persist in how homework is handled in class. Exhibit 6 also shows a higher percentage of FiW eighth–grade math students reported that homework is assigned during "most lessons" (86 percent of FiW eighth–grade students versus 72 percent of U.S. eighth graders).

Classroom time spent on homework-related activities follows a slightly different pattern in eighth grade than in fourth grade. In the eighth grade, FiW students are much more likely than U.S. students to report that they discuss their completed homework in class during "most lessons" (72 percent of FiW eighth–graders versus 54 percent of U.S. eighth–graders).

In both FiW and U.S. math classes, eighth–grade math students reported that they are less likely to spend time in class working on homework than in the fourth grade. But, unlike in the fourth grade, FiW eighth–grade students are less likely than their U.S. counterparts to report that they can start their homework in class during "most lessons" (32 percent of FiW eighth–graders versus 50 percent of U.S. eighth–graders).

As discussed earlier in this section, it appears as if most FiW fourth–and eighth–grade students have the same types of experiences in their math classes as their fellow U.S. students.

According to student accounts, the most frequently emphasized activities in the FiW and the U.S., in both fourth– and eighth–grades, are:

(1) teacher demonstrations;
(2) homework distribution, checking or discussion of homework; and
(3) independent work on worksheets or on material in the textbook.

The three areas in eighth grade where students report differences between the U.S. and the FiW are:

(1) calculator use;
(2) beginning homework in class; and
(3) discussing completed homework.

These reports support the findings reported in the two preceding sections, and suggest that important differences between what FiW and U.S. students do in class may exist.

Exhibit 6: Students' Reports on the Frequency of Math Class Activities

Activity	Frequency	Percent of Fourth-Grade Students		Percent of Eighth-Grade Students	
		FiW	U.S.	FiW	U.S.
The teacher shows us how to do math problems	Most Lessons	72	73	83	78
	Some Lessons	27	25	16	21
	Never	1	2	2	1
We copy notes from the board	Most Lessons	22	32	47	42
	Some Lessons	61	48	43	49
	Never	17	20	10	9
We have a quiz or test	Most Lessons	32	48	46	39
	Some Lessons	65	47	53	61
	Never	2	5	1	1
We work from worksheets or textbooks on our own	Most Lessons	56	55	69	59
	Some Lessons	40	35	29	38
	Never	4	10	2	3
We use calculators	Most Lessons	16	15	69	38
	Some Lessons	75	46	28	50
	Never	9	39	2	11
We use computers	Most Lessons	6	16	3	4
	Some Lessons	35	29	34	28
	Never	58	55	63	67
The teacher gives us homework	Most Lessons	74	66	86	72
	Some Lessons	26	30	14	27
	Never	1	4	1	2
We can begin our homework in class	Most Lessons	40	36	32	50
	Some Lessons	43	33	64	44
	Never	16	31	4	7
The teacher checks our homework	Most Lessons	64	67	58	56
	Some Lessons	30	25	35	37
	Never	6	8	7	7
We discuss our completed homework	Most Lessons	40	35	72	54
	Some Lessons	47	37	24	37
	Never	13	28	4	9

SOURCE: NCREL analysis of TIMSS data; FiW Student Questionnaire results.
NOTE: Totals may not add to 100 due to rounding.

*The fourth grade and eighth grade student questionnaires contained a set of slightly different possible responses to this question. To make comparisons across grades, some categories from the grade 8 survey were combined. These new categories, along with the remaining responses were then matched to similar items on the grade 4 survey. Accordingly, "Some Lessons" is the sum of responses to "Pretty Often" and "Once in a While" on the grade 8 survey. Also, "Most Lessons" is "Almost Always" on the grade 8 survey.

Summary

In summary, data on instructional practices indicate that there are differences between FiW and U.S. fourth– and eighth–grade math classes. According to students, the most common activities in both the FiW and the U.S. show similarities, with students reporting that the four most frequently used activities were:

(1) teacher demonstrations of how to do math problems;
(2) teacher assigning of homework;
(3) teacher checking of homework (grade 4)/class discussions of homework (grade 8); and
(4) students working from worksheets or textbooks on their own.

Teacher and student reports indicate that FiW and U.S. math teachers rely on different methods when demonstrating how to do math problems.

In the fourth grade, FiW teachers rely on a variety of approaches for teaching, so that no one method dominates. Perhaps reflecting the different way in which younger students learn and process material, some instructional time is spent in large groups, some in small groups, and some individually.

In the eighth grade, however, FiW teachers report that the most frequently used method involves the math teacher instructing the whole class. This approach is used far more frequently than in U.S.–eighth grade math classes.

In addition, in the FiW, both fourth–and eighth–grade students are more likely than U.S. students to be asked to explain the reasoning behind an idea, or write an equation to represent a relationship.

According to teacher reports, FiW students receive instruction in large and small groups more frequently than their U.S. counterparts, with the form of instruction varying according to the grade level. In all cases, FiW math teachers are more likely than U.S. math teachers to challenge their students to demonstrate their mastery of more difficult ideas or concepts.

The data also indicate that differences exist in how homework is assigned and used. FiW students are more likely than U.S. students to have homework assigned every day and to discuss their completed homework in class.

This pattern of homework assignment and use may mean that FiW students spend more time outside of class reinforcing new concepts. Classroom discussions of homework may clarify common difficulties and serve to solve outstanding problems.

In the fourth–grade, FiW math students are also more likely to spend class time starting their homework in class. Until the content of the homework is analyzed, however, it is difficult to determine whether this time enhances instruction by allowing teachers to work more directly with their students on a regular basis.

Teacher Engagement

Teacher engagement and involvement in the instructional process as well as in general school activities may also have an impact on student achievement. Although it can be difficult to measure teacher engagement directly, a number of factors can give us insight into the overall level of engagement and commitment.

For example, the amount of time and effort that math teachers put into preparing and planning for their classes, both during the regular school day and outside of regular classroom hours, may provide a good indication of teacher engagement.

Similarly, the amount of influence that teachers have over basic school budget allocation and curriculum decisions provide another useful measure.

Teacher familiarity with key curriculum and assessment documents may offer an indication of the level of knowledge of significant reform efforts.

Data from the TIMSS teacher surveys suggest that teachers in the FiW may be more engaged in school activities than U.S. teachers. Accordingly, this section presents data on four measures of teacher engagement:

- teacher involvement in school-related activities outside the school day;
- frequency of teacher meetings;
- teacher influence over key school decisions; and
- teacher familiarity with key curriculum and assessment documents.

Together, these measures provide some insight into the relative levels of teacher engagement in the FiW and the U.S.

Teacher Involvement in School-related Activities Outside the School Day

Many teachers spend time outside the school day involved in school-related activities. The types of activities that they undertake are varied and range from preparing for class activities (e.g., planning lessons and grading homework) to helping, teaching, or working with individual students (e.g., tutoring students, meeting with parents, or consulting with other educational personnel on the progress of a particular student).

Teachers may also spend time outside the school day attending to administrative or other record-keeping tasks (e.g., attending staff meetings, updating class grade books). Teacher involvement in any of these activities are used as a proxy for the level of teacher engagement.

FiW and U.S. teachers spend similar amounts of their own time outside the formal school day working on nearly all types of school-related activities, with FiW fourth– and eighth–grade math teachers more likely than U.S. teachers to spend their own time on a few key activities.

Exhibit 7 contains data on teachers' reports of hours spent per week on activities outside the formal school day. Larger percentages of FiW students than U.S. students—at both the fourth–and eighth–grade levels—have teachers who report spending more than three hours per week planning lessons by themselves.

In the fourth grade, 67 percent of FiW students have teachers who spend more than

three hours a week preparing lessons outside the formal school day, compared to 46 percent in the U.S., according to teacher's reports.

In the eighth grade, 48 percent of FiW students have teachers who spend over three hours per week preparing for classes outside of the formal school day, as compared to 34 percent of U.S. students.

In the eighth grade, larger percentages of FiW students than U.S. students have teachers who devote more than three hours per week to preparing or grading student tests or exams outside the classroom.

Seventy-two percent of FiW students have teachers who spend over three hours a week of their own time preparing or grading student tests or exams, compared to 47 percent of U.S. students. This difference is not found in the fourth grade.

Differences also exist between FiW and U.S. eighth–grade students with regard to how much time their teachers spend meeting with students outside the classroom. On average, eighth–grade FiW teachers spend more time meeting with their students on their own time than U.S. teachers (3.2 hours/week in FiW versus 2.0 hours/week in U.S.). Teachers of 72 percent of FiW eighth–grade students report that they spend over three hours a week meeting with their students, as compared to teachers of 29 percent of U.S. students.

To summarize, TIMSS teacher questionnaire data indicate that FiW and U.S. fourth–and eighth–grade math students have teachers who spend similar amounts of time outside the classroom on many school-related activities.

Differences exist in the amount of time spent on a number of activities, however.

According to the data, FiW fourth–and eighth–graders are more likely than U.S. students to have teachers who spend their spare time preparing lessons.

In addition, eighth–grade FiW students are more likely to have teachers who spend more of their spare time preparing or grading tests and meeting with students outside of their class, perhaps suggesting higher levels of teacher engagement among FiW teachers than among U.S. teachers.

Exhibit 7: Teachers' Reports on Hours Spent Per Week on Activities Outside the Formal School Day

Activity	Hours Spent Per Week	Percent of Fourth Grade Students		Percent of Eighth Grade Students	
		FiW	U.S.	FiW	U.S.
Preparing or grading student tests or exams	More than 3 hours	26	25	72	47
	Average (in hours)	2.0	2.2	3.4	2.7
Reading and grading other student work	More than 3 hours	76	65	48	46
	Average (in hours)	3.6	3.1	2.6	2.7
Planning lessons by yourself	More than 3 hours	67	46	48	34
	Average (in hours)	3.2	2.5	2.8	2.4
Meeting with students outside of classroom time	More than 3 hours	6	6	72	29
	Average (in hours)	1.1	0.9	3.2	2.0
Meeting with parents	More than 3 hours	0	0	0	1
	Average (in hours)	0.6	0.7	0.7	0.7
Professional reading and development activity	More than 3 hours	15	12	0	6
	Average (in hours)	1.2	1.3	0.9	0.9
Keeping students' records up to date	More than 3 hours	19	16	34	16
	Average (in hours)	1.9	1.4	2.1	1.6
Administrative tasks including staff meetings	More than 3 hours	45	37	37	27
	Average (in hours)	2.5	2.2	2.4	2.0

SOURCE: NCREL analysis of IEA's Third International Mathematics and Science Study (TIMSS) data, 1994–95; FiW Teacher Questionnaire results, NCREL; table 5.5 in Mullis, I.V.S., *et al.* (1997). *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Sciences Study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College; table 5.6 in Beaton, A. E., *et al.* (1996). *Mathematics Achievement in the Middle School Year: IEA's Third International Mathematics and Science Study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

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Frequency of Teacher Meetings

Another indicator of teacher engagement is how actively teachers seek feedback on ways to improve instruction. Teacher meetings to plan and discuss curriculum and instructional approaches allow teachers to get feedback from their colleagues on the best methods to present different types of topics, or the relative ease or difficulty that other classes are having covering similar material.

Teacher meetings not only allow teachers to learn about more effective strategies for teaching their respective subjects, but also permit teachers to keep abreast of changes in major national, state, and local curricular standards and assessments. Further, they may provide important opportunities for teachers to share resources and ideas for instructing and motivating their students.

As shown in exhibit 8, FiW students are more likely than U.S. students to have teachers who report meeting frequently with other teachers in their subject area to discuss and plan curriculum or teaching approaches.

In the fourth grade, 26 percent of FiW students have teachers who meet with their colleagues daily to discuss curriculum. In contrast, 10 percent of U.S. students have teachers who meet with their colleagues this frequently.

This gap between FiW and U.S. is even more pronounced for weekly teacher encounters. Eighty-one percent of FiW fourth–grade students have teachers who meet with other teachers at least once a week, compared to 59 percent in the U.S. (These percentages are calculated by combining the following categories: "almost every day" + "two or three times a week" + "once a week").

In both FiW and U.S. schools, eighth–grade math teachers meet with their colleagues less frequently than fourth–grade math teachers. However, notable differences exist between FiW and the U.S.

Approximately half (51 percent) of FiW eighth–grade students have teachers who report that they meet with other teachers to plan at least once a week, compared to about one–third of U.S. students (34 percent). (Again this is calculated by combining the categories noted above).

At the other end of the spectrum, a notable gap also exists between the FiW and the U.S. One–third of U.S. eighth–grade students have teachers who meet with their colleagues two or fewer occasions (never, once, or twice) over the course of a full school year. Three percent of FiW students fall into this category.

As with the TIMSS data on the amount of out-of-school time that teachers devote to their work, data on the frequency teacher meetings also suggest that FiW fourth–and eighth–grade math teachers may be more engaged than their U.S. counterparts in planning curriculum and seeking feedback from their colleagues.

Disparities between the number of students whose teachers participate in weekly planning sessions are most noteworthy, and exist at both the fourth–and eighth–grade levels.

Exhibit 8: Teachers' Reports on the Frequency of Meetings with Other Teachers in Their Subject Area to Discuss and Plan Curriculum or Teaching Approaches

Frequency	Percent of Fourth Grade Students		Percent of Eighth Grade Students	
	First in the World	United States	First in the World	United States
Almost every day	26	10	5	9
Two or three times a week	17	14	25	9
Once a week	38	35	21	16
Once a month	7	18	29	23
Every other month	7	5	15	12
Once or twice a year	5	16	1	25
Never	0	2	2	8

SOURCE: NCREL analysis of TIMSS data; FiW Teacher Questionnaire results, NCREL.
NOTE: Totals may not add to 100 due to rounding.

Teacher Influence Over Key School Decisions

The level of teacher involvement in school budget and curricular decisions can also provide yet another indication of the level of teacher engagement. Although the degree to which states and districts allow their teachers to be involved in these discussions varies considerably, actively engaged teachers may exert a lot of influence over these decisions, while teachers who are less engaged in improving curriculum, instruction, or the overall school environment may not.

This section looks at data on the influence that eighth–grade math teachers in the FiW and the U.S. have over basic school decisions. (Data are not available for fourth graders).

As shown in exhibit 9, eighth–grade math students in the FiW Consortium were more likely than U.S. students to have math teachers who report they have a lot of influence over key school decisions.

Nearly half (47 percent) of FiW eighth–grade students had teachers who reported having "a lot" of influence over the subject matter to be taught.

Ninety-two percent of FiW eighth–grade math students had teachers who reported that they had at least "some" (if not "a lot") of influence over the subject matter to be taught.

By contrast, U.S. students tended to have teachers who reported that they had less control. Thirty-eight percent of U.S. students had teachers who reported that they had "a lot" of control over the subject matter, and 73 percent had teachers who felt they had at least "some" control. Seventy-four percent of FiW eighth–grade math students had math teachers who claimed they have "some" or "a lot" of control over which textbooks are used, compared to only 63 percent of U.S. eighth–graders.

This difference may reflect the fact that, in some schools, these choices are made at the state or district level.

FiW eighth–grade students were also more likely than U.S. students to have math teachers who reported that they have "a lot" of control over what supplies are purchased (47 percent of FiW teachers compared to only 23 percent of U.S. teachers).

However, FiW eighth–grade students are more likely than U.S. students to have math teachers who felt they had no control over the amount of money to be spent on supplies (46 percent in FiW compared to 35 percent in the U.S.).

Since not all schools or districts allow teachers to have a say in budgetary matters, it is not clear that these data indicate higher levels of teacher involvement in the FiW than in the U.S. However, they do indicate that FiW teachers have a greater influence on these decisions than their U.S. counterparts.

In summary, data indicate that eighth–grade FiW students are more likely to be taught by teachers who have control over some curricular and budget decisions.

Again, these findings reinforce the data reported earlier in the section that FiW teachers may be more engaged than their U.S. counterparts (to the extent that these data capture not only teacher influence, but also teacher engagement)

Exhibit 9: Teachers' Reports on Their Influence over School Decisions

School Decision	Amount of Influence	Percent of Eighth Grade Students	
		FiW	U.S.
Subject matter to be taught	A lot	47	38
	Some	45	35
	Little	6	18
	None	2	9
Specific textbooks to be used	A lot	39	27
	Some	35	36
	Little	22	18
	None	4	19
The amount of money to be spent on supplies	A lot	13	4
	Some	16	27
	Little	25	35
	None	46	35
What supplies are purchased	A lot	47	23
	Some	43	41
	Little	10	29
	None	0	7

SOURCE: NCREL analysis of TIMSS data, FiW Teacher Questionnaire results.
NOTE: Totals may not add to 100 due to rounding.

Exhibit 10: Teachers' Reports on Their Familiarity with Key Curriculum Documents

Document	Familiarity	Percent of Eighth–Grade* Students				
		FiW	U.S.	Japan	Korea	Singapore
National Curriculum Guide for Mathematics (US: National Council of Teachers of Mathematics (NCTM) Professional Standards for Teaching Mathematics)	Very Familiar	69	38	3	4	75
	Fairly Familiar	31	48	71	41	23
	Not Familiar	0	13	19	44	2
	No Such Document	0	0	7	11	0
Regional (State) Curriculum Guide for Mathematics	Very Familiar	10	27	1	1	0
	Fairly Familiar	21	36	37	26	0
	Not Familiar	67	35	36	48	0
	No Such Document	2	2	26	25	100
National Examination Specifications (US: The National Assessment for Educational Progress (NAEP) Assessment Frameworks/Specifications)	Very Familiar	0	16	1	4	62
	Fairly Familiar	16	24	29	24	36
	Not Familiar	82	58	41	48	2
	No Such Document	2	3	29	24	0
Regional (State) Examination Specifications	Very Familiar	11	4	2	1	0
	Fairly Familiar	33	28	67	28	0
	Not Familiar	56	68	17	47	0
	No Such Document	0	0	14	24	100

SOURCE: NCREL analysis of IEA's Third International Mathematics and Science Study (TIMSS) data, 1994–95; FiW Teacher Questionnaire results, NCREL.

NOTE: Totals may not add to 100 due to rounding.
*Eighth grade in most countries.

Teacher Familiarity with Key Curriculum and Assessment Documents

As scientists, mathematicians, and researchers make advances in math and science, school textbooks and other classroom materials must be periodically updated to reflect new knowledge and ways of thinking. Standards, curriculum guidelines, and student assessment instruments also undergo regular revisions and updates so that they can accurately reflect current and emerging research and best practices.

Thus, key local, state, and national standards, curriculum, and assessment documents typically reflect the most current math and science knowledge. Teacher familiarity with, and knowledge of, these documents may provide another indication of how engaged teachers are in keeping abreast of the latest advances in math and science curriculum and assessment.

This section looks at FiW teacher familiarity with major curriculum and assessment documents. Comparative FiW and U.S. data, and those from other nations are only presented at the eighth–grade level because of limited data availability. It should also be noted that there are some definitional issues with the international comparisons, therefore these data should be interpreted with caution.

As illustrated in exhibit 10, FiW eighth–grade students have teachers who show varying degrees of familiarity with key curriculum documents. Most show the greatest familiarity with national standards. Sixty-nine percent of FiW students have teachers who are "very familiar" and 31 percent have teachers who are "fairly familiar" with the National Council of Teachers of Mathematics (NCTM) standards. In contrast, 38 percent of U.S. students have teachers who are "very familiar" and 48 percent who are "fairly familiar" with the NCTM standards.

In high math achievement countries, the pattern varies across countries. In Singapore, teachers of most students were "very familiar" with equivalent documents, while in Japan and Korea, students were more likely to have teachers who report that they are "fairly familiar" but not "very familiar."

The comparison to U.S. teachers' familiarity may indicate that FiW teachers have a greater involvement with professional associations, place more emphasis on professional knowledge, or have more opportunities to pursue outside interests.

The responses of the high performing Asian teachers are much less clear. While teachers in Singapore indicate a similar familiarity with their national curriculum, those in Japan and Korea do not. Some believe the data from Japan and Korea reflect an understated familiarity, as opposed to a lack of knowledge.

FiW teachers are less familiar with state curriculum guides than national guidelines. Math teachers of less than half of FiW eighth–grade students are "very familiar" or "fairly familiar" with state curriculum guides. U.S. math teachers are more familiar with these curriculum guides. Sixty-three percent of U.S. students have teachers who report they are "very familiar" or "fairly familiar" with these guides.

This lack of familiarity could also be a function of when, and if, states had

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completed development of their state standards.[29]

As for familiarity with exam specifications for mathematics, math teachers of most FiW fourth and eighth grade students report that they are "not familiar" with the U.S. equivalent of national exam specifications—the National Assessment of Educational Progress (NAEP). This is probably because Illinois does not participate in the NAEP.

In the U.S., 16 percent of students have teachers who are "very familiar" with NAEP, and 24 percent have teachers who are "fairly familiar" with NAEP.

While FiW teachers report more familiarity with state exam specifications than with NAEP, they do not report particularly high levels of familiarity with state exams. In fact, teachers of at least half of the FiW eighth– grade math students report that they are "not familiar" with state exam specifications.

This pattern differs slightly for the U.S. In the U.S., more eighth grade math students have teachers who are "very familiar" or "fairly familiar" with the NAEP than with their state exams.

As was the case with state curriculum frameworks or standards, this could be more a function of state policy than teacher familiarity.

In summary, TIMSS questionnaire data on teacher familiarity with key curriculum documents and exam specifications reinforce some of the earlier findings on teacher engagement. Although data are not available at the fourth–grade level, FiW eighth–grade teachers report high levels of familiarity with the NCTM Standards, unlike U.S. teachers.

Data on state teaching guides and exam specifications show lower levels of teacher familiarity, in both the FiW and the U.S. High degrees of familiarity with national curriculum standards are also found in some high math achievement countries, but not all. It is unclear, however, whether this pattern reflects actual differences in familiarity or in understated familiarity (particularly in the case of Japan and Korea).

Summary

In summary, the TIMSS data indicate that FiW students have teachers that indicate more engagement than U.S. teachers in a broad array of school-related activities.

These activities include participating in school-related activities outside the school day, meeting with their colleagues, identifying and selecting textbooks, buying supplies, and keeping up with new curriculum and instructional developments and techniques.

Other research has posited that one result of greater teacher engagement is more stimulating, organized, and/or tailored instruction. While certainly not conclusive, these data may suggest that a key component to delivering better math instruction may be encouraging more active teacher participation in classroom planning, school decision-making, and keeping abreast of key changes in curriculum and assessments.

Teaching Environment

In addition to the key factors already discussed, the environment for teaching may also have an important impact on instruction, and in turn, student achievement. Teachers who must deal frequently with non-academic issues within the classroom may not have as much time to devote to instruction.

For example, many teachers must routinely spend class time dealing with discipline problems or disruptive students. External factors may also contribute to, or detract from, teaching environments in the FiW and the U.S.

In particular, state-, school district-, or school-based decisions and policy priorities which affect either the availability of equipment, the adequacy of physical facilities, or the student/teacher ratio may have an impact on the teaching environment.

Exhibit 11 presents data on teachers' reports on the factors that limit their ability to teach their classes. These reports show similar patterns exist between FiW and the U.S. and high performing countries (Japan, Korea and Singapore). In both the fourth–and eighth–grades, across all countries, the three most frequently cited factors limiting teachers' abilities to teach by "quite a lot" or "a great deal" were:

(1) students with different academic abilities;
(2) high student/teacher ratios; and
(3) disruptive students.

While different percentages of teachers from these countries reported that these factors placed "quite a lot" or "a great deal" of limitations on their ability to teach, in nearly all cases, students with different academic abilities were reported to be one of the most important limiting factors.

The only exception was for eighth–grade math students from Singapore, where students were more likely to be taught by teachers who report that high student/teacher ratios were the most important limitation placed on their ability to teach their class.

Across nearly all categories, FiW students were less likely than their counterparts in the U.S. and in high–achieving countries to have teachers who report that critical factors limit their ability to teach their class.

At the other extreme, students in Korea were the most likely to have teachers who reported that the various factors placed "quite a lot" or a "great deal" of limitations on them.

Fewer students had teachers who reported shortages of equipment as limiting factors. In the fourth grade, teachers of four percent of FiW math students reported that equipment shortages limited their ability to teach by "quite a lot" or "a great deal," compared to teachers of approximately 25 percent of students in the U.S., Japan, and Singapore.

As they did with all factors, Korean teachers reported that equipment shortages placed more limitations on their ability to teach, with teachers of 54 percent of students indicating that this limited their teaching ability "quite a lot" or "a great deal."

A similar pattern was found on the equipment shortages in the eighth–grade data from the FiW, U.S. and high achievement countries. The relative wealth

of FiW districts probably has an impact on the differences in these results.

In summary, the TIMSS teacher data indicate that FiW, U.S., and high math–achieving countries report similar patterns in the factors that affect their ability to teach math. The limitation at the top of the list in the FiW, U.S. and all high–math achieving math countries except Singapore is dealing with students with a range of academic abilities. Students in Singapore were more likely to have teachers who reported high student/teacher ratios as their most important limitation. Concerns over facilities and supplies were less important limitations for all countries.

Exhibit 11: Teachers' Reports on the Factors that Limit How They Teach Mathematics Class

Country	**Percent of students whose teachers report each factor limiting how they teach class as "quite a lot" or "a great deal"**			
	Students with Different Academic Abilities	Disruptive Students	Shortage of Equipment for Use in Demonstrations and Other Exercises	High Student/Teacher Ratio
*Fourth Grade**				
FiW	36	15	4	18
United States	41 r	31 r	25 r	38 r
Japan	60	--	28	41
Korea	69	64	54	62
Singapore	66	42	25	60
*Eighth Grade**				
FiW	32	21	7	25
United States	44 r	39 r	20 r	29 r
Japan	63	--	12	42
Korea	77	60	31	67
Singapore	55	44	25	60

SOURCE: Figure 5.4 in Mullis, I.V.S., *et al.* (1997). *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College; figure 5.3 in Mullis, I.V.S., *et al.* (1998). *Mathematics Achievement in Missouri and Oregon in an International Context: 1997 TIMSS Benchmarking*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College; FiW Teacher Questionnaire results.

*Fourth/Eighth grade in most countries.
A double dash (--) indicates data are not available. This question was not included on questionnaires for teachers of Japanese students.
An "r" indicates teacher response data available for 70-84 percent of students.

Summary

In sum, differences in the contexts for teaching and learning between the FiW and the U.S. may offer some insight into possible explanations for the gap in achievement levels between these two groups.

Accordingly, the preceding sections examined four broad areas that help define the context for teaching and learning for possible clues as to the factors that might drive these differences: curriculum, instructional practices, teacher engagement, and the teaching environment.

Differences in curriculum may contribute to the differences in achievement between the FiW and the U.S. These achievement gaps do not seem to be driven by differences in the number of topics covered by the textbooks used by the FiW and U.S. students, as the numbers of topics addressed by U.S. and FiW textbooks are similar.

FiW eighth–grade textbooks, however, tend to focus on algebra and geometry more heavily than U.S. books do, perhaps reflecting the difference in course-taking behavior.

Nor do the differences seem to be driven by a more focused coverage of topics in the classroom, since FiW students spend class time on just as many topics as their U.S. peers. However, FiW students seem to be introduced to more advanced topics earlier than U.S. students. This pattern is found in both the fourth– and eighth–grades, and, as might be expected, is even more pronounced in the eighth grade.

Data on instructional practices indicate that differences exist between FiW and U.S. fourth and eighth grade math classes. According to students, the FiW and the U.S. show similar patterns with respect to the four most frequently used activities. However, TIMSS data suggest that FiW and U.S. math teachers rely on different methods when demonstrating how to do math problems.

In the fourth grade, FiW teachers rely on a variety of approaches for teaching; no one method dominate—some instructional time is spent in large groups, some in small groups, some working individually.

In the eighth grade, however, the most frequently used classroom organizational method—in the FiW and in high math achievement countries—involves the math teacher teaching the whole class; this approach is used far more frequently than in U.S. eighth grade math classes. These data suggest that FiW students may have math teachers who use direct teaching styles more frequently than their U.S. counterparts, with the form of instruction varying according to the grade level.

In addition, both FiW fourth and eighth grade students are more likely to be asked to do reasoning tasks than to spend time practicing computational skills.

The data also indicate important differences in how homework is assigned and used. FiW students are more likely than U.S. students to have homework assigned every day and to discuss their completed homework in class. Classroom discussions of homework may help to clarify common difficulties and serve to solve outstanding problems that their students encounter.

Together, these results suggest that FiW math teachers are more likely than U.S.

math teachers to challenge their students to demonstrate their mastery of more advanced ideas or concepts.

The TIMSS data also suggest that FiW students may have teachers that are more engaged than U.S. teachers in a broad array of school-related activities. These include participating in school-related activities outside the regular work day, meeting with their colleagues, identifying and selecting textbooks, buying supplies, and keeping up with new curriculum and instructional developments and techniques.

Finally, similar patterns were found in teacher reports on the type of factors that limit their teaching abilities. Across the FiW, the U.S., and high achieving math countries, teachers reported similar patterns: student factors most limited their ability to teach, while the adequacy of class was less limiting.

FiW teachers reported that the adequacy of supplies hindered their ability to teach very little, no doubt reflecting the relatively high wealth of the districts.

While certainly not conclusive, these data suggest that key components of delivering a world-class math education may be encouraging the earlier introduction of advanced math topics into the curriculum and spending more time in the classroom concentrating on instruction.

Efforts to encourage active teacher participation in classroom planning, school decision-making, and keeping abreast of key changes in curriculum and assessments are also likely to be beneficial.

What is the FiW Consortium Doing to Improve Math and Science?

The Consortium is launching numerous activities as part of its effort to improve math and science programs and to identify world-class standards in instruction, assessment, and curriculum development.

The Consortium also works hard to disseminate its findings to educators, researchers, and policymakers by participating in numerous presentations and seminars. Working closely with its partners, it has also taken full advantage of advances in technology to disseminate materials documenting the FiW's progress to others via the World Wide Web. (*http://www.ncrel.org /fitw/homepage.htm*)

Across the spectrum of activities undertaken by the FiW, educators have maintained their commitment to including all students in the achievement of math and science. Reflecting this commitment, students with disabilities were included in the sample of students taking TIMSS, and special education teachers participate in each of the Consortium's Teacher Learning Networks (TLNs).

This section focuses on one of the most fully developed of these activities, the FiW's efforts to establish TLNs, networks of learning communities involving educators, parents, and community leaders.

This section also describes the FiW efforts in this area, as well as one TLN's efforts to improve science instruction by examining the TIMSS results in light of current FiW instructional practices.

Teacher Learning Networks: Collaborative Learning Communities

The Consortium's TLNs grew out of a cross-district planning effort that involved teachers from all districts and all levels of education, Consortium administrators, and outside advisors. After the Consortium was formed, planning teams were established to conceptualize a structure for developing learning communities that would extend beyond district boundaries.

These learning communities build upon the professional development efforts of the individual districts in order to promote systemic change. The planning teams included teachers from each of the high schools in the Consortium, as well as teachers from the elementary schools.

Working in collaboration with the professional development specialists from North Central Regional Education Laboratory, the planning teams developed a structure to engage teachers across four key domains. These areas are:

- *Curriculum models.* This network examines the Consortium's curriculum using techniques similar to those used by the International and National TIMSS Centers. It allows teachers to promote cross-district and cross-grade coordination of curriculum, as well as greater alignment with national and international standards. Network members also explore differences and similarities of different districts on the sequence, emphasis, and content covered in math and science courses.

- *Instructional practices and models.* This network focuses on encouraging the implementation of instructional practices that promote engaged learning for students. Network members explore various instructional methods, including problem-based learning, hands-on science, and activity-centered teaching.

- *Assessment strategies.* This network assists the Consortium in using assessments to support decisions and establish school improvement plans. It places particular emphasis on the use of performance-based assessments in place of traditional testing formats. Members also look at the importance of integrating teaching with assessment and methods of alternative instruction that inform instructional practices.

- *Technology.* This network explores the potential for using different forms of technology to support and augment math and science education.

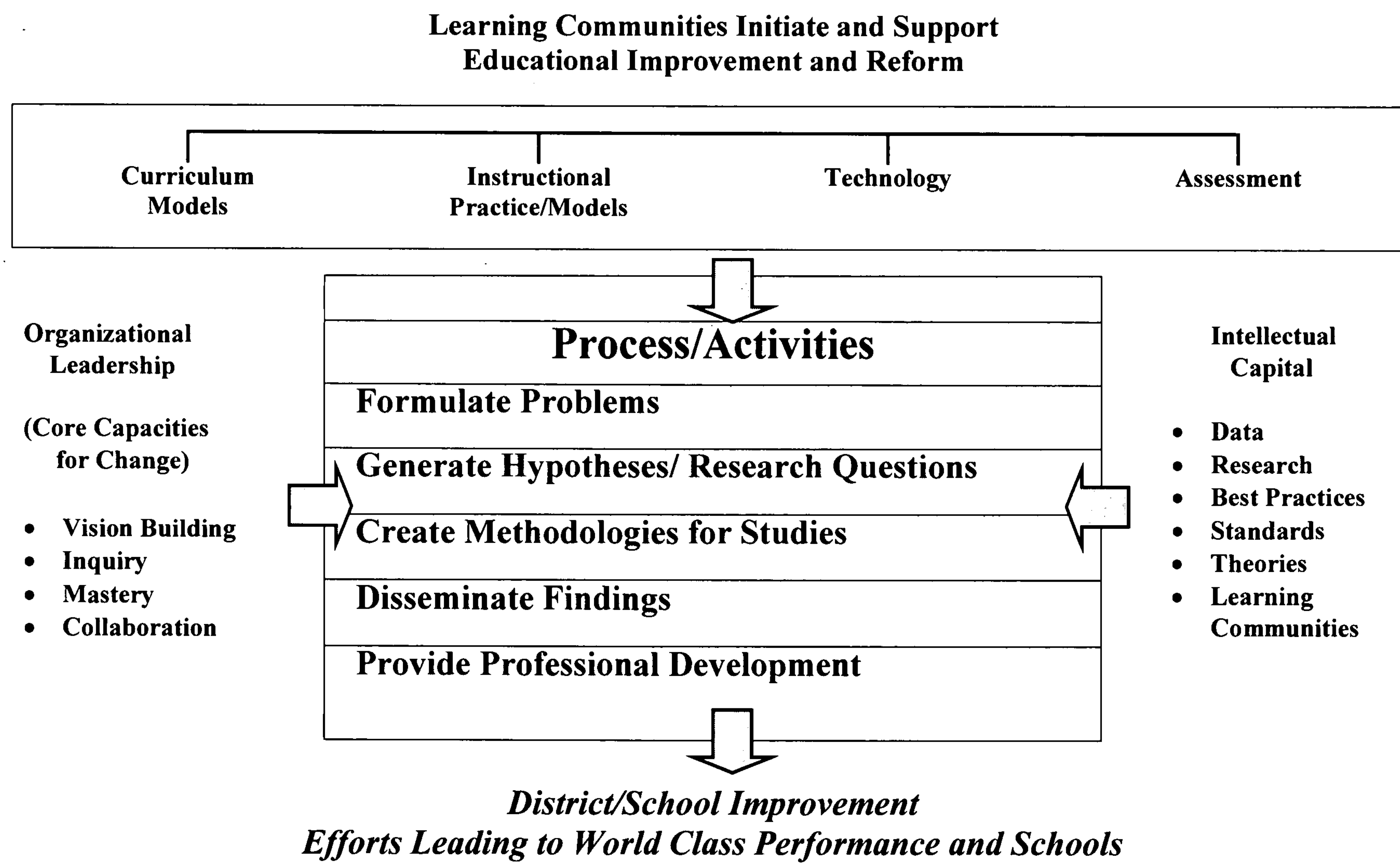
As shown in exhibit 12, the structure of the Teacher Learning Networks relies on the organizational, intellectual, and creative resources of the FiW Consortium, its partners, and the education community. Approximately 75 teachers are involved in the learning network activities.[30]

The TLNs are supported by the Instructional Support Network (ISN), a group of curricular and instructional directors who provide technical support to the TLNs. The ISN collects and assists in the interpretation of data and assesses the systemic functioning of the networks.

In addition, FiW teachers and staff can draw upon data and expertise available from the Department of Education and/or NCREL. They can also make use of the research on the best practices for teaching math and science being undertaken by these organizations.

Finally, the learning communities themselves also function as a form of intellectual capital to other teachers and administrators for improving math and science achievement.

Exhibit 12: First in the World Teacher Learning Networks



SOURCE: Kimmelman, Paul., Kroeze, David., (August 1998). Presented materials and handouts, Seminar on the First in the World Consortium. Sponsered by The National Institute on Student Achievement, Curriculum, and Assessment. Office of Educational Research and Improvement. Symposium conducted at the U.S. Department of Education, Washington, DC.

Teacher Network Grants

Teacher network grants are small grants provided to Consortium staff interested in pursuing staff development activities, locally initiated action research, or curriculum development initiatives in math and science. The FiW leadership identified the two primary objectives of the teacher network grants as follows:

- *To improve the teaching of math and science through self-identified and Consortium-identified areas of study.* The teacher network grants allow teachers to identify areas of study that have direct links to their abilities to teach math and science.

- *To allow practitioners to take an active role in network activities while both providing and receiving services.* These cross-district activities allow teachers and others to learn from and interact with their colleagues at other schools within their district, as well as their colleagues in other FiW districts.

To receive a grant, a network member or district must submit a proposal to the Consortium's Grant Review Committee on a topic for study in one of the four network areas (curriculum, instruction, assessment, or technology).

The proposal must outline the project's goals, planned activities, budget, and the methods by which its outcome will be shared with other districts within the Consortium. Grant applications are reviewed by a Grant Review Committee, which is made up of staff and administrative representatives.

Proposals are assessed according to criteria established by the FiW Board of Directors. Funding is provided for proposals that meet these four criteria:

(1) congruence with the Consortium's annual working plan;
(2) direct teacher or staff input;
(3) the availability of activities and outcomes for all Consortium districts; and
(4) focus on math and science.

During the 1997–98 school year, approximately 20 grants were awarded.[31] Grants were awarded for work on the following general topics in the four network areas:

Curriculum Models

- Curriculum continuity for math and science from kindergarten through grade 12;

- Analyzing physics concepts and the systematic introduction of concepts to students; and

- Mentoring program for females in math and science.

Instructional Practices and Models

- Implications of brain research in the teaching and learning process;

- Staff development to improve instruction for students with moderate to severe learning disabilities; and

- Training staff in problem-based learning.

Assessment Strategies

- Determining teacher knowledge about assessment;
- Aligning instruction and assessment practices for students; and
- Retooling science activities and assessments for students with disabilities.

Technology

- Designing web pages to further math and science learning experiences.

As they pursue their projects, the TLNs are responsible for organizing themselves to promote their own learning.

In particular, the networks are intended to foster exploration of the extent to which teachers' classroom practices are consistent with both

(1) their stated beliefs about teaching and learning, and
(2) current and emerging research and best practice.

Furthermore, the networks are exploring ways to enhance consistency between current classroom practice and research on best practices.

In addition, network members are expected to lay the groundwork for the expansion of these networks into larger, more inclusive learning communities.

Example of a FiW Teacher Learning Network: Analysis of FiW Physics Achievement

To provide an illustration of the types of activities undertaken by a TLN, this section presents an example of work being undertaken a group of teachers to use the TIMSS results to improve the Consortium's science curriculum and instruction.

With assistance from researchers at NCREL, high school physics teachers decided to take a close look at the performance of FiW students on physics-related questions on TIMSS, FiW physics-related curriculum, and instructional practices and beliefs of FiW physics teachers.

Although much of this report focuses on differences in math achievement, this example was chosen because it illustrates how FiW educators are using the TIMSS benchmark, along with supplemental data, to improve science achievement.

This section describes the project's goals and participants, its initial results, and the potential areas initially identified for future research by the project's participants.

As noted earlier, the FiW results on the twelfth grade physics exam were lower than anticipated, with twelve nations scoring significantly above the FiW, three nations obtaining scores not significantly different from the FiW, and one nation scoring significantly below the FiW.

To gain fuller insight into what it takes to become first in the world in physics achievement, six current and former physics teachers[32] met over the summer of 1998. At these meetings, they reviewed the FiW physics results from TIMSS, as well as their

instructional and curricular practices and discussed what they could do to improve physics achievement.

This cross-district effort built on the teachers' considerable experience and commitment to improve science instruction. Between them, the six teachers have more than 100 years of combined physics teaching experience, and all are extremely active in professional development activities and organizations.

Project Activities

After initial meetings with NCREL staff to review the TIMSS physics questions and discuss the high school results, team members identified three project activities. These activities were designed not only to give the network members a better understanding of the FiW students' relative strengths and weaknesses in solving physics problems, but also to give them a better understanding of the context for learning and teaching physics in FiW and the variety of instructional approaches used across the Consortium.

The project activities are:

- *Analyzing FiW students' performance on physics exams using groups of similar TIMSS test questions.* This analysis was limited to the use of released TIMSS test questions, a relatively small sample of questions. To conduct this analysis, the released physics questions from the eighth grade science exam and the twelfth grade physics exam were grouped according to conceptual models in physics (e.g., particles, matter, light, ideal gas, systems, relativistic physics, and force laws). FiW student response patterns were then compared to the response patterns of U.S. students and the international average.

- *Extending the TIMSS teacher survey to a sample of FiW high school science teachers.* The TLN administered one of the two TIMSS teacher surveys that had been prepared for TIMSS but not used during the study. (Unlike in the fourth and eighth grades, TIMSS did not collect data from twelfth–grade teachers). The TLN collected data on teacher beliefs and attitudes using one of these surveys.

- *Creating and administering a pilot teacher survey to collect data on values, style, and "rigor" in physics classrooms.* This task involved creating and administering the Teacher Survey of Rigor, a new survey to a sample of physics teachers. The new survey was intended to collect additional data on how physics courses are similar or different in style of delivery, expectations for students and what teachers value as important. The anticipated survey results also are expected to complement the results from the TIMSS teacher survey.

As these activities demonstrate, the FiW teacher learning networks provide a unique opportunity for their members to work with, and learn from, their peers.

Furthermore, they allow FiW teachers to tap into NCREL analysts and researchers, as well as their colleagues in other districts, in their efforts to become first in the world in math and science.

Initial Results

At the time of this writing, the analyses undertaken by this network team are at

different stages of completion. Initial results are available from the TIMSS questionnaire analysis, while the two additional surveys are in the very early stages of analysis.

Nevertheless, the preliminary results have already pointed to areas where the FiW might work toward improving its physics instruction.

The initial results from the analysis of TIMSS physics questions done by NCREL point to areas of relative strength and weakness in FiW physics achievement. One area of interest was in the different topical areas and different achievement levels.

For example, FiW results for eighth–grade science show strength in the physical sciences with few exceptions. One of these exceptions was questions associated with the atomic model, on which FiW students showed their lowest performance.

Twelfth– grade FiW students demonstrated strength on questions related to the Newtonian concept of force. Questions in modern physics and mechanical waves showed the lowest performance levels.

One unexpected result highlighted by the analysis was that FiW students scored better on questions dealing with constant gravitational force than constant electric or magnetic force, despite the fact that the same general concepts apply to both areas.

The analysis of TIMSS results on the twelfth grade physics exam also gave the FiW teachers a fuller understanding of the types of problem-solving skills needed to achieve world class standards in physics. For example, the teachers discovered that few questionnaire items could be answered using rote memory.

In addition, they discovered that all of the TIMSS countries obtained relatively low performance levels on the physics assessment. On average, only 31 percent of the items were answered correctly.

Also, FiW physics students performed better when tackling certain types of test questions. In particular, they had higher performance on multiple choice items (as opposed to free response items) than the international sample.

Topics for Further Research Identified by the Physics Teachers' Learning Network

Based on their preliminary research, the team has already identified several questions that they feel may deserve future attention:

(1) Are similar trends repeated in the TIMSS questions that were not released?
(2) Why do all students (International, U.S., and FiW) perform poorly on the TIMSS physics assessment?
(3) Can conceptual models be traced through the fourth, eighth, and twelfth grades?
(4) How do students perform on experimental design and scientific process items?

To address these questions, the TLN has identified some opportunities for expanding their investigation that may be particularly fruitful. In particular, they recommend broadening the analysis to include all FiW schools, as well as an examination of student results on the fourth–grade TIMSS science assessment.

They also hope to work on identifying groups that might yield richer comparisons on what it means to be first in the world (e.g., identifying an appropriate comparison

group of FiW physics students or group of nations that might be present for all three test populations).

Finally, based on the results of the survey analysis, they plan to look for appropriate physics content that might strengthen their curriculum in areas where FiW student achievement was not as high.

Summary

The Consortium has begun to embark on a host of activities to define and clarify world class standards and establish learning communities. The establishment of TLNs, networks of learning communities involving educators, parents, and community leaders, represents one of the most fully developed of these activities.

As a result of a cross-district planning effort involving teachers from all education levels, Consortium administrators, and outside advisors, the networks engage participants in four key domains:

(1) curriculum models,
(2) instructional practices and models,
(3) assessment strategies, and
(4) technology.

These learning communities build upon and contribute to the professional development efforts of individual districts and leverage the organizational, intellectual, and creative resources of the FiW Consortium, its partners, and the education community.

To facilitate the work of the TLNs, small grants are available to Consortium faculty interested in pursuing staff development activities, locally initiated action research, or curriculum development initiatives in math and science.

During the 1997–98 school year, approximately 20 grants were awarded. Throughout the upcoming year, the networks and grant recipients will explore ways to enhance consistency among current classroom practice, current and emerging research, and best practice, as illustrated by the ambitious agenda of activities undertaken by a team of physics teachers.

Working with the Consortium's partners, these teachers are successfully using the TIMSS benchmark, along with supplemental data, to examine physics curriculum and instruction across districts and grade levels.

Summary and Conclusion

In conclusion, the effort begun by a group of small school districts north of Chicago has already begun to show some promising results. Motivated to take the National Education Goals seriously, this consortium embarked upon a detailed plan of action to "become first in the world in math and science by the year 2000."

As a first step in their plan, Consortium students became the only school districts to take part in TIMSS, the most ambitious, comprehensive, and rigorous international assessment of math and science yet undertaken.

In contrast to the U.S., the FiW performed exceptionally well on the Consortium's initial benchmark, indicating that they are well on their way to achieving their goal. In fact, TIMSS results indicate that fourth and eighth grade students performed at, or near, the top of the world in both math and science.

In the twelfth grade, results were more mixed. Although students taking the general knowledge assessments achieved world class standards, FiW students taking the advanced math and physics exams performed near the international average. However, FiW AP students taking the advanced math and physics exams, perhaps a better group to use for international comparisons, performed at the top of the world.

Given the Consortium's performance, this report explored some of the possible reasons why they did so well compared to the U.S. by focusing on math. Initial analyses of the relationship between FiW and U.S. math achievement and student and family socio-economic background characteristics found that home and family characteristics could explain less than half of the difference in scores.

Accordingly, differences in the contexts for teaching and learning math between the FiW and the U.S. were examined as possible explanations of the remaining gaps between these two groups.

Four broad areas were explored:

(1) curriculum,
(2) instructional practices,
(3) teacher engagement, and the
(4) teaching environment.

Although similar patterns were reported in all of these areas, important differences did emerge.

The review of curriculum and textbook data found that the number of topics addressed by U.S. and FiW math textbooks is similar and FiW students spend class time on just as many topics as their U.S. peers.

Nevertheless, some differences do exist between FiW and U.S eighth grade math textbooks, with FiW eighth–grade textbooks more focused on algebra and geometry than U.S. books.

In addition, FiW students seem to be introduced to more advanced topics earlier than U.S. students. This pattern is found in both the fourth–and eighth–grades, and, as might be expected, is even more pronounced in the eighth grade.

TIMSS data on instructional practices also suggest additional differences between FiW and U.S. fourth and eighth grade math classes. Although students report that similar patterns in the four most frequently used activities, the data indicate that FiW and U.S. math teachers rely on different methods when demonstrating how to do math problems.

In the fourth grade, FiW teachers rely on a variety of approaches for teaching; no one method dominates. In the eighth grade, by contrast, group instruction of the whole class is reported as the most frequent classroom organizational approach in the FiW and high math–achievement countries.

This approach is used far more frequently than in U.S. eighth–grade math classes, suggesting that FiW students may have math teachers who use direct teaching styles more frequently than their U.S. counterparts, with the form of instruction varying according to the grade level.

The TIMSS data also suggested differences between the types of math activities performed by FiW and U.S. in class. In particular, FiW fourth–and eighth–grade math students are more likely than U.S. students to be asked to perform reasoning tasks than to spend time practicing computational skills.

In addition, important differences exist in how homework is assigned and used. FiW students are more likely than U.S. students to have daily homework and to discuss these completed assignments in class. Together, these results suggest that FiW math students may be more challenged than U.S. students to show their mastery of more advanced ideas or concepts.

As for teacher engagement, FiW students may have teachers that are more engaged than U.S. teachers in a wide assortment of school-related activities. Examples include participating in school-related activities outside the regular work day, meeting with their colleagues, identifying and selecting textbooks, buying supplies, and keeping up with new curriculum and instructional developments and techniques.

Similar patterns were also found in teacher reports on teaching environments. Across the FiW, the U.S., and high achieving math countries, teachers reported similar patterns: student factors most hindered their ability to teach, while the adequacy of class supplies was less of a limitation. FiW teachers reported that the adequacy of supplies limited their ability to teach very little, no doubt reflecting the relatively high wealth of the districts.

These data suggest that key components of delivering a top notch math education may be introducing advanced math topics into the curriculum earlier and spending more time in the classroom concentrating on instruction.

Efforts to foster active teacher participation in classroom planning, school decision-making, and to allow teachers opportunities to learn about key changes in curriculum and assessments are also likely to be positive.

The FiW Consortium knows that these international achievement benchmarks are not static. While FiW students have done well in 1996, this success does not guarantee continued success since the achievement benchmark may be set at a different point in 1999 and in coming years.

Accordingly, the FiW Consortium has also

begun its efforts to define and clarify world-class standards in instruction, assessment, and curriculum. Working with its partners at the regional and national level, the Consortium is identifying current and emerging research and best practices in all of these areas.

Recognizing that the current context for teaching and learning within the FiW consortium may also provide some clues as to what it takes to do well in math and science, the Consortium is also exploring the TIMSS data for suggestions as to which instructional, curricular, and assessment practices may work well in the U.S.

Finally, the Consortium has worked hard to create a structure for developing a cross-district community of learners that would involve educators, parents, and community leaders.

It has established teacher learning networks in four areas: curriculum, assessment, instruction, and technology; and awarded grants to groups of teachers pursuing projects in these areas. These projects, along with the other efforts of learning networks, will lay the groundwork for the expansion of these networks into larger, more inclusive learning communities.

Taken together, these results and activities provide exciting news. They illustrate not only that U.S. students have the potential to become the first in the world in math and science, but also that districts can work in a collaborative, cooperative manner to strive towards this goal.

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Endnotes

[1] The Third International Math and Science Study is the largest, most comprehensive, and most rigorous international comparison of math and science achievement ever undertaken.

[2] Consortium membership has changed over the past several years. This section presents data on the districts that currently make up the Consortium's membership. Exhibit A-1 in appendix A lists the districts that currently make up the Consortium.

[3] Average includes all districts except the Northern Suburban Special Education District. Average expenditures in the Northern Suburban Special Education District range from $8,000 to $25,000 per student, depending on the type of student disability.

[4] Current expenditure per pupil in fall enrollment public and elementary schools. National Center for Education Statistics, *Digest of Education Statistics,* table 169.

[5] First in the World Consortium. Low-income students include those who receive public aid, live in institutions for neglected or abandoned children, are supported in foster homes, or are eligible to receive free or reduced price lunch. This figure does not include data on students from the North Suburban Special Education District.

[6] See exhibit A-2 in appendix A for more detail.

[7] National Center for Education Statistics, *Digest of Education Statistics,* table 69. Data are from 1996.

[8] North Central Regional Educational Lab, FiW Web Site, Purpose and History. These figures do not include data on students or faculty from the Illinois Mathematics and Science Academy and the North Suburban Special Education District.

[9] See exhibit A-2 in appendix A for additional data on average teacher salaries in FiW districts.

[10] National Center for Education Statistics, *Digest of Education Statistics,* table 77. Data are from 1995–96.

[11] The topic areas discussed here and presented in exhibit B-3 are those which were determined by Michigan State University to more closely relate to those included in the TIMSS textbook analysis and teacher questionnaires. They are different than the topic areas used by the International TIMSS Center at Boston College and reported in the international comparisons.

[12] The topic areas presented in exhibit B-6 are those which were determined by Michigan State University to more closely relate to those included in the TIMSS textbook analysis and teacher questionnaires. They are different than the topic areas used by the International TIMSS Center at

Boston College and reported in the international comparisons.

[13] First in the World Consortium. *Achieving Excellence: Initial Findings from Twelfth-Grade Students in the Third International Mathematics and Science Study.* p. 3. Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzales, E.J., Kelly, D.L., and Smith, T.A. (1997). *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College. p. 19.

[14] First in the World Consortium. *Achieving Excellence: Initial Findings from Twelfth-Grade Students in the Third International Mathematics and Science Study.* p. 3. Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzales, E.J., Kelly, D.L., and Smith, T.A. (1997). *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College. p. 19.

[15] First in the World Consortium. *Achieving Excellence: Initial Findings from Twelfth-Grade Students in the Third International Mathematics and Science Study.* p. 4.

[16] First in the World Consortium. *Achieving Excellence: Initial Findings from Twelfth-Grade Students in the Third International Mathematics and Science Study.* p. 3.

[17] Internal NCREL memo from Bill Quinn to Jeri Nowakowski, July 17, 1998.

[18] Preliminary analyses undertaken by NCES have found similar effects.

[19] TIMSS administered teacher surveys to teachers of fourth- and eighth-grade students but did not administer teacher surveys to teachers of students in twelfth grade.

[20] The authors of this report looked at TIMSS data items that might point to areas that could explain achievement differences based on knowledge of FiW districts and educational research findings. No claims are being made as to the statistical significance of these findings.

[21] Note that the instructional topics shown in exhibit 1 differ slightly from those presented in exhibit B-3. The categories used in exhibit B-3 are those used by the U.S. TIMSS Center at Michigan State University, while those presented in exhibit 1 correspond to the categories used in the TIMSS teacher survey.

[22] Note that the instructional topics shown in exhibit 2 differ slightly from those presented in exhibit B-6. The categories used in exhibit B-6 are those used by the U.S. TIMSS Center, while those presented in exhibit 2 correspond to the categories used in the TIMSS teacher survey.

[23] The group of U.S. textbooks used for this analysis is described in Schmidt, William H., McKnight, Curtis C., Raizen, Senta A. (1996). *Splintered Vision: An Investigation of U.S.*

Science and Mathematics Education: (Executive Summary). Boston, MA: Kluwer Academic Publishers.

[24] United States National Research Center, Third International Mathematics and Science Study. *First in the World: Curriculum Analysis Final Report*. East Lansing: Michigan State University. 1998.

[25] United States National Research Center, Third International Mathematics and Science Study. *First in the World: Curriculum Analysis Final Report*. East Lansing: Michigan State University. 1998, p. 6.

[26] United States National Research Center, Third International Mathematics and Science Study. *First in the World: Curriculum Analysis Final Report*. East Lansing: Michigan State University. 1998, p. 6.

[27] United States National Research Center, Third International Mathematics and Science Study. *First in the World: Curriculum Analysis Final Report*. East Lansing: Michigan State University. 1998, p. 6.

[28] United States National Research Center, Third International Mathematics and Science Study. *First in the World: Curriculum Analysis Final Report*. East Lansing: Michigan State University. 1998, p. 9.

[29] The U.S. TIMSS questionnaires were completed in spring 1995, at a time when many states were still developing their mathematics standards.

[30] Kroeze, David, and Daniel Johnson. *Achieving Excellence: A report of initial findings of eighth grade performance from the Third International Math and Science Study,* p. 2.

[31] First in the World. First in the World Consortium Science and Mathematics Grant Program 1998–98. Material from FiW Web Site, ***www.ncrel.org/fitw***.

[32] The teachers had taught or were currently teaching at Glenbrook North High School, Glenbrook South High School, New Trier High School and Illinois Mathematics and Science Academy.

Appendix A: Contact Information and Characteristics of First in the World Consortium Districts

Exhibit A-1: List of First in the World Districts

K-8 School Districts

Avoca School District No. 37
Dr. John W. Sloan, Superintendent
2921 Illinois Rd.
Wilmette, IL 60091
847-251-3587
Web: www.avoca.k12.il.us

Frankfort Community Consolidated School District 157-C
Dr. Pamela Witt, Superintendent
10482 West Nebraska St.
Frankfort, IL 60423-2235
815-469-5922

Glenview Community Consolidated No. 34
Dr. Thomas Rich, Interim Superintendent
1401 Greenwood Ave.
Glenview, IL 60025
847-998-5000
Web: www.ncook.k12.il.us

Golf School District 67
Dr. Linda Marks, Superintendent
9401 Waukegan Rd.
Morton Grove, IL 60053-1353
847-966-8200

Lincolnwood School District No. 74
Dr. Steve Lake, Superintendent
6950 E. Prairie Rd.
Lincolnwood, IL 60645
847-675-8234

Mount Prospect District No. 57
Dr. Maureen L. Hager, Superintendent
701 W. Gregory Street
Mt. Prospect, IL 60056-2220
847-394-7300
Web: www.ncesc.org/dist57

Niles Elementary School District No. 71
Dr. Eugene Zalewski, Superintendent
6935 W. Touhy Avenue
Niles, IL 60714
847-647-9752

Northbrook School District No. 27
Dr. David J. Kroeze, Superintendent
1250 Sanders Rd.
Northbrook, IL 60062
847-498-2610
Web: www.northbrook27.k12.il.us

Northbrook School District No. 28
Dr. James Kucienski, Superintendent
1475 Maple Ave.
Northbrook, IL 60062
847-498-7900
Web: www.district28.k12.il.us

Northbrook/Glenview School District No. 30
Dr. Harry Rossi, Superintendent
2374 Shermer Road
Northbrook, IL 60062
847-498-4190

Sunset Ridge School District No. 29
Dr. Howard Bultinck, Superintendent
525 Sunset Ridge Road
Northfield, IL 60093
847-446-6383

West Northfield School District No. 31
Dr. Paul L. Kimmelman, Superintendent
3131 Techny Rd.
Northbrook, IL 60062
847-272-6880, ext. 223

Wheeling School District No. 21
Dr. Lloyd "Bud" DesCarpentrie, Superintendent
999 W. Dundee Rd.
Wheeling, IL 60090
847-537-8270

High School Districts

Glenbrook School District No. 225
Dr. David Hales, Superintendent
1835 Landwehr Rd.
Glenview, IL 60025
847-998-6100
Web: www.glenbrook.k12.il.us

New Trier School District No. 203
Dr. Henry Bangser, Superintendent
385 Winnetka Rd.
Winnetka, IL 60093
847-501-6310
Web: nths.newtrier.k12.il.us

Niles Township School District No. 219
Dr. Grif Powell, Superintendent
7700 Gross Point Rd.
Skokie, IL 60077
847-568-3590
Web: www.niles-hs.k12.il.us

Special Education District

Northern Suburban Special Education District
SEJA-804
Mr. David Peterson, Superintendent
760 Red Oak Ln.
Highland Park, IL 60035
847-831-5100

Residential School

Illinois Mathematics & Science Academy
Dr. Stephanie Pace Marshall, President
1500 W. Sullivan Rd.
Aurora, IL 60506
630-907-5037
Web: mocha.imsa.edu

SOURCE: *http://www.ncrel.org/fitw/1stpages/members.htm*

NOTE: This list is the First in the World Consortium membership as of November 1998.

Exhibit A-2: First in The World District Characteristics

School Districts	# of Schs	Enrollment	Percentage (%): Ethnicity: Wh	AfrAm	Hisp	A/PI	Low Income	LEP	Teachers: B.A.	M.S.+	# of Tchrs	Teacher Salaries	Per Pupil Expenditure
K-8													
Avoca School District #37	2	653	80.8	0.6	1.0	17.6	1.9	3.8	49.0	51.0	49	$ 47,057	$ 9,491
Frankfort School District #157C	3	1,393	96.0	0.8	1.0	2.1	0.1	0.0	80.2	19.8	68	$ 35,575	$ 4,492
Glenview School District # 34	7	3,592	77.1	2.8	8.0	11.7	12.0	7.9	26.4	73.6	236	$ 46,891	$ 7,313
Golf School District # 67	2	534	70.0	0.4	4.8	24.7	9.7	19.1	59.6	40.4	43	$ 44,135	$ 9,483
Lincolnwood School District #74	3	1,266	99.1	0.0	0.0	0.9	3.7	0.0	30.5	69.5	106	$ 53,188	$ 8,769
Mount Prospect School District # 57	3	1,770	91.7	1.4	2.7	4.1	1.5	3.6	47.9	52.1	101	$ 46,439	$ 7,896
Niles Elementary School District #71	2	533	70.0	0.9	2.3	26.4	19.1	8.4	29.7	70.3	39	$ 53,586	$ 9,098
Northbrook School District #27	4	1,448	86.1	0.4	1.4	12.1	0.7	2.7	34.4	65.6	126	$ 48,569	$ 9,191
Northbrook School District #28	4	1,706	91.3	0.1	0.7	7.9	0.6	5.3	59.1	40.9	145	$ 47,258	$ 10,334
Northbrook/Glenview School District #30	3	1,195	81.0	0.1	2.1	16.8	0.6	2.5	28.8	71.2	85	$ 51,025	$ 8,229
Sunset Ridge School District #29	2	512	91.0	0.0	0.6	8.4	0.4	2.7	41.8	58.2	41	$ 43,942	$ 9,706
West Northfield School District # 31	2	939	66.5	1.0	4.2	28.4	3.0	7.4	41.4	58.6	68	$ 51,128	$ 9,100
Wheeling School District #21	12	7,152	68.5	2.7	21.9	6.9	17.8	14.4	44.3	55.7	453	$ 46,697	$ 6,792
Sum	**49**	**22,693**									**1,560**		
Average	**3.77**	**1,746**	**79.4**	**1.6**	**9.1**	**9.8**	**8.8**	**7.9**	**42.2**	**57.8**	**120**	**$ 47,339**	**$ 7,781**
High School													
Glenbrook High School District #225	2	4,091	77.0	1.0	3.3	18.6	4.4	3.7	18.0	82.0	284	$ 65,000	$ 12,100
New Trier High School District #203	1	3,006	85.6	1.0	2.3	11.0	1.0	2.5	27.7	72.3	249	$ 66,762	$ 13,786
Niles Township High School District #219	2	4,230	60.3	1.9	5.8	31.9	7.4	4.9	25.4	74.6	270	$ 64,158	$ 11,641
Sum	**5**	**11,327**									**803**		
Average	**1.67**	**2,989**	**73.0**	**1.3**	**4.0**	**21.5**	**4.6**	**3.8**	**23.5**	**76.5**	**268**	**$ 65,263**	**$ 12,376**
Special Education													
Northern Suburban Special Ed District	1	1,602	84.4	5.8	3.4	6.8	--	--	44.0	56.0	--	$ 42,311	$ 8,000-25,000
Residential School													
Illinois Mathematics/Science Academy	1	628	52.0	9.0	6.0	28.0	8.0	0.0	2.0	98.0	--	$ 55,112	**$ 12,700**
State													
State	--	--	63.3	20.6	12.8	3.1	35.7	6.1	54.2	45.6	--	$ 42,429	$ 6,158
First in the World	56	36,250	77.2	1.8	7.2	13.7	* 7.1	* 6.1	--	--	--	--	$ * **8,958**

SOURCE: First in the World Consortium.

A double dash (--) indicates no data.

* Figure was calculated from K–8 and High School numbers only. Special Education figures were not included.

NOTES: 1. This table presents data on districts in the First in the World Consortium as of winter 1999.

2. District data from 1996–97 school state report card.

3. Attendance was of September 1996.

4. Low income is defined as families eligible to receive free or reduced price lunch.

5. Operating expenditure per pupil is based on 1995–96 data.

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Appendix B:
FiW TIMSS Achievement Results

Appendix B: FiW TIMSS Achievement Results

Exhibits B-1 through B-12 present data on the average achievement of each country that participated in the different TIMSS assessments, as well as visual representations of the distribution of each country's scores.[1] The distributions show student achievement at the 5^{th}, 25^{th}, 75^{th} and 95^{th} percentiles. The dark black band in the middle of each country's distribution is the mean plus or minus two standard errors; this band is intended to emphasize the point that each country's average score is only an estimate of the true score.

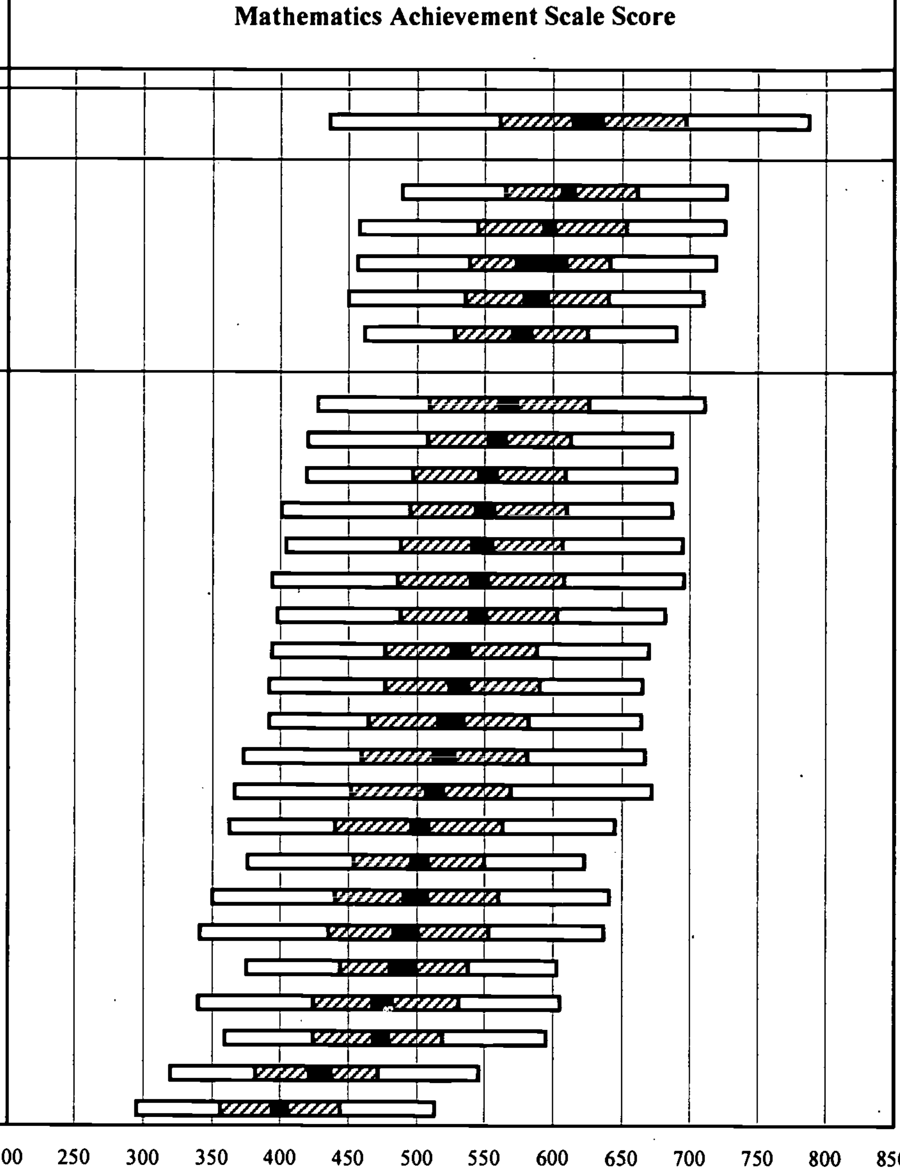
The exhibits in this section should be interpreted with caution. Because these data were generated using statistical sampling procedures, the average scores are represented with their appropriate error bands. Therefore, average scores for countries overlap one another in many cases. Thus, it is incorrect to state that the FiW ranked x out of y countries. Rather, countries have been grouped according to whether their scores are significantly above, not significantly different from, or significantly below the scores for the FiW. Nevertheless, as the data in these exhibits illustrate, there is considerable variation in scores both within and across countries.

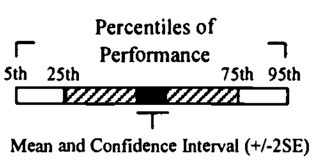
Since the TIMSS assessment was administered, two school districts have not continued to participate in FiW activities (Wilmette School District #39 and Glencoe School District #35). The results reported here include students from these districts.

[1] Note that different groups of countries participated in each of the different assessments. See figure B-1 of Mullis, I.V.S., et al., *Mathematics and Science Achievement in the Final Year of Secondary School* for a summary of countries that participated in different assessments.

Exhibit B-1: Distributions of Mathematics Achievement in the Fourth Grade

Country	Mean†
Higher than FiW	
Singapore	625 (5.3)
Same as FiW	
Korea	611 (2.1)
Japan	597 (2.1)
First in the World	591 (9.1)
Hong Kong	587 (4.3)
(Netherlands)	577 (3.4)
Lower than FiW	
Czech Republic	567 (3.3)
(Austria)	559 (3.1)
(Slovenia)	552 (3.2)
Ireland	550 (3.4)
(Hungary)	548 (3.7)
(Australia)	546 (3.1)
United States	545 (3.0)
Canada	532 (3.3)
(Israel)	531 (3.5)
(Latvia {LSS})	525 (4.8)
Scotland^	520 (3.9)
England*^	513 (3.2)
Cyprus	502 (3.1)
Norway	502 (3.0)
New Zealand	499 (4.3)
Greece	492 (4.4)
(Thailand)	490 (4.7)
Portugal	475 (3.5)
Iceland	474 (2.7)
Iran, Islamic Republic	429 (4.0)
(Kuwait)	400 (2.8)





SOURCE: Student Achievement Data, NCREL; tables 1.1, C.1, and C.3 in Mullis, I.V.S., *et al.* (1997). *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

* Nations in which more than 10 percent of the population was excluded from testing. Latvia is designated LSS because only Latvian-speaking schoo were tested, which represents less than 65 percent of the population.

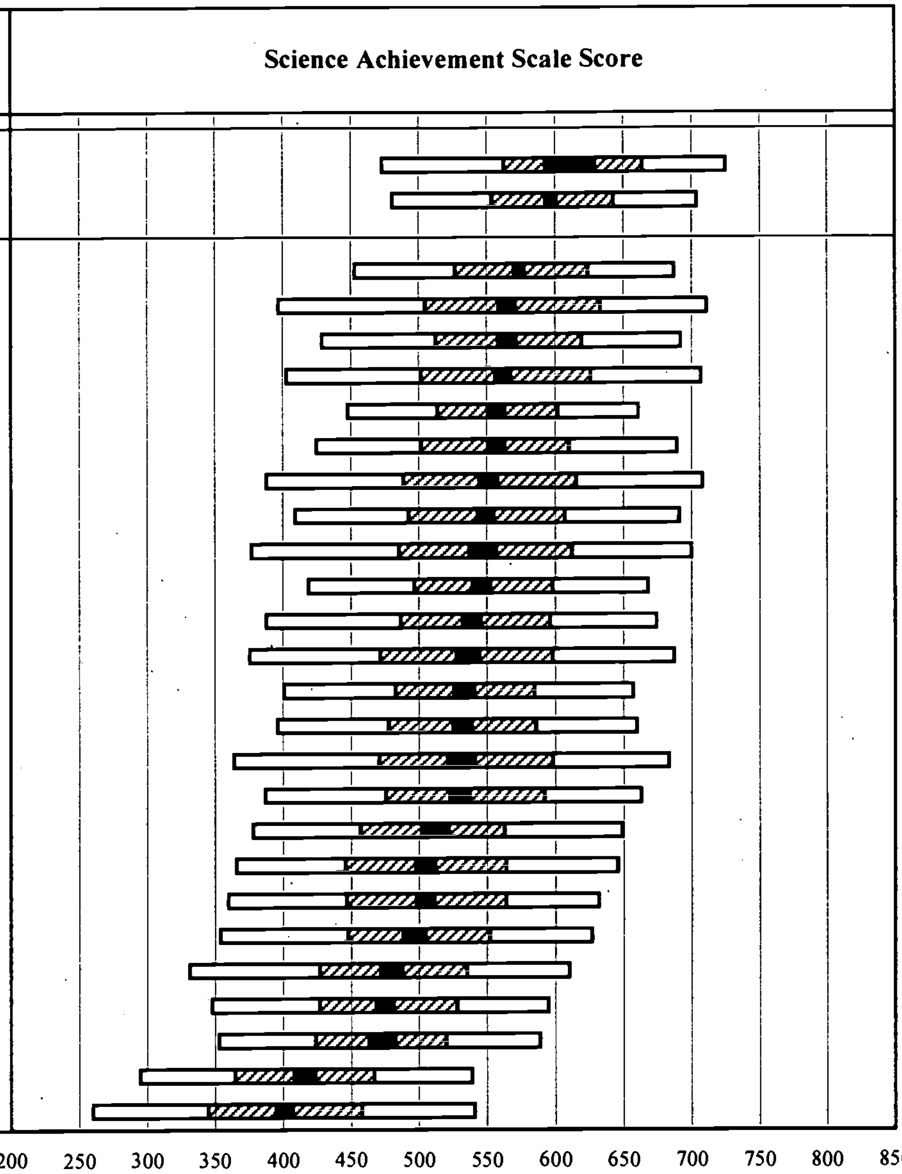
^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

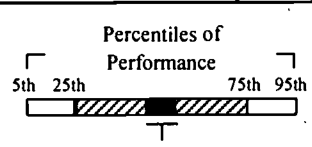
† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

Exhibit B-2: Distributions of Science Achievement in the Fourth Grade

Country	Mean†
Same as FiW	
First in the World	611 (9.0)
Korea	597 (1.9)
Lower than FiW	
Japan	574 (1.8)
United States	565 (3.1)
(Austria)	565 (3.3)
(Australia)	562 (2.9)
(Netherlands)	557 (3.1)
Czech Republic	557 (3.1)
England*^	551 (3.3)
Canada	549 (3.0)
Singapore	547 (5.0)
(Slovenia)	546 (3.3)
Ireland	539 (3.3)
Scotland^	536 (4.2)
Hong Kong	533 (3.7)
(Hungary)	532 (3.4)
New Zealand	531 (4.9)
Norway	530 (3.6)
(Latvia {LSS})	512 (4.9)
(Israel)	505 (3.6)
Iceland	505 (3.3)
Greece	497 (4.1)
Portugal	480 (4.0)
Cyprus	475 (3.3)
(Thailand)	473 (4.9)
Iran, Islamic Republic	416 (3.9)
(Kuwait)	401 (3.1)





SOURCE: Student Achievement Data, NCREL; tables 1.1, C.1, and C.3 in Martin, Michael O., *et al.* (1997). *Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

* Nations in which more than 10 percent of the population was excluded from testing. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.

^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

Exhibit B-3: Fourth-Grade Mathematics Performance, by Subtopic

Average Percent Correct

Meaning of Whole Numbers	
Higher than FiW	
Korea	88.1
Same as FiW	
First in the World	81.7
Singapore	81.6
Japan	79.9
Lower than FiW	
Hong Kong	76.4
Hungary	74.5
Netherlands	73.3
Czech Republic	72.9
Israel	69.8
United States	69.8
Australia	68.9
Canada	68.7
INTERNATIONAL	65.9
Norway	61.4
New Zealand	59.1
England	59.0
Thailand	57.3

Integers & Whole Number Operations	
Same as FiW	
Korea	82.5
Japan	80.2
Singapore	79.2
First in the World	78.6
Hong Kong	76.9
Czech Republic	74.4
Lower than FiW	
Netherlands	73.2
Hungary	71.5
United States	67.6
Israel	66.3
INTERNATIONAL	64.1
Canada	61.5
Australia	61.5
Norway	57.6
England	53.1
Thailand	52.7
New Zealand	50.8

Common Fractions	
Same as FiW	
Singapore	71.8
First in the World	65.7
Hong Kong	65.3
Japan	62.5
Korea	61.5
Hungary	61.2
Netherlands	60.2
Lower than FiW	
United States	53.7
Israel	53.3
Australia	52.0
Canada	50.4
Czech Republic	49.7
INTERNATIONAL	50.0
England	49.1
Thailand	46.4
New Zealand	45.3
Norway	39.2

Decimal Fractions	
Higher than FiW	
Singapore	83.2
Korea	75.0
Hong Kong	72.6
Japan	71.3
Same as FiW	
First in the World	59.7
Lower than FiW	
Netherlands	47.1
United States	46.8
INTERNATIONAL	44.6
Australia	43.7
Thailand	43.6
Canada	41.5
Czech Republic	40.1
Hungary	36.4
Israel	34.2
England	32.0
Norway	28.9
New Zealand	26.3

Estimating Quantity & Size	
Higher than FiW	
Japan	78.0
Hong Kong	70.5
Czech Republic	67.9
Hungary	67.3
Korea	67.0
Netherlands	65.9
Singapore	65.3
Australia	61.2
Norway	60.6
Same as FiW	
INTERNATIONAL	57.2
First in the World	52.9
England	52.2
New Zealand	51.9
Canada	50.7
Israel	50.5
Thailand	49.8
United States	47.1

Rounding & Estimating Computations	
Same as FiW	
Korea	76.8
Japan	74.8
Hong Kong	74.8
Singapore	74.3
First in the World	73.8
Netherlands	68.7
Hungary	68.6
Czech Republic	68.1
United States	67.2
Lower than FiW	
Canada	61.6
Israel	61.2
Australia	59.4
INTERNATIONAL	55.2
New Zealand	47.9
England	47.7
Norway	46.4
Thailand	39.1

Measurement Units	
Higher than FiW	
Japan	76.5
Korea	72.1
Netherlands	72.0
Czech Republic	68.2
Hong Kong	67.6
Hungary	66.3
Same as FiW	
Singapore	61.3
Australia	60.2
Norway	60.0
First in the World	58.0
INTERNATIONAL	56.8
Lower than FiW	
England	52.3
Canada	51.7
Israel	51.0
New Zealand	49.7
United States	48.0
Thailand	43.2

Perimeter, Area, & Volume	
Higher than FiW	
Singapore	75.9
Korea	73.5
Same as FiW	
Netherlands	71.0
Hong Kong	70.8
Czech Republic	68.2
Japan	67.5
First in the World	65.9
Hungary	62.8
Australia	62.2
Lower than FiW	
Canada	59.3
INTERNATIONAL	58.8
United States	58.3
Israel	57.1
England	55.2
Norway	54.5
New Zealand	49.1
Thailand	48.2

Geometry: Position & Shapes	
Same as FiW	
First in the World	77
Australia	71.9
Lower than FiW	
England	70.6
Netherlands	70.3
Hong Kong	70.1
Canada	69.4
United States	67.7
Czech Republic	67.4
Japan	66.7
Singapore	65.3
New Zealand	65.3
Korea	65.1
Hungary	62.3
INTERNATIONAL	61.7
Israel	59.1
Norway	58.3
Thailand	47.6

Symmetry, Congruence, & Similarity	
Same as FiW	
Singapore	88.9
Korea	88.8
Hong Kong	85.4
First in the World	85.2
England	80.9
Lower than FiW	
Australia	79.9
Japan	79.5
United States	78.5
Canada	78.5
Czech Republic	77.8
Netherlands	74.1
Hungary	73.3
INTERNATIONAL	70.5
New Zealand	69.1
Israel	69.0
Thailand	66.5
Norway	56.1

Proportionality	
Same as FiW	
Singapore	63.7
Netherlands	62.7
First in the World	59.4
Korea	58.1
Japan	57.7
Czech Republic	57.3
Hungary	55.5
Hong Kong	53.3
Lower than FiW	
Australia	51.3
England	46.6
Israel	46.0
INTERNATIONAL	45.6
United States	45.5
Canada	43.8
New Zealand	43.7
Norway	40.8
Thailand	34.0

Patterns, Relations, & Functions	
Same as FiW	
Korea	85.0
First in the World	78.0
Hong Kong	77.8
Singapore	77.5
Japan	77.2
Lower than FiW	
Hungary	71.4
Netherlands	70.4
Czech Republic	69.8
Australia	69.6
United States	69.1
Canada	67.1
INTERNATIONAL	63.2
Israel	62.6
England	62.0
New Zealand	57.5
Norway	54.7
Thailand	52.4

Equations & Formulas	
Higher than FiW	
Korea	85.3
Same as FiW	
Japan	84.3
Singapore	82.6
First in the World	78.5
Hong Kong	76.9
Hungary	72.4
Netherlands	72.2
Lower than FiW	
Czech Republic	71.0
Israel	66.8
United States	65.6
INTERNATIONAL	62.0
Canada	61.4
Australia	60.0
Thailand	54.0
New Zealand	50.5
Norway	49.5
England	48.2

Data & Statistics	
Same as FiW	
First in the World	86.4
Lower than FiW	
Singapore	80.8
Korea	79.8
Japan	78.3
Hong Kong	75.8
Netherlands	75.4
United States	73.0
Canada	68.0
Czech Republic	67.1
Australia	67.1
England	65.8
Israel	63.4
New Zealand	61.5
INTERNATIONAL	61.8
Hungary	60.3
Norway	59.5
Thailand	55.5

SOURCE: U.S. National TIMSS Center, Michigan State University.

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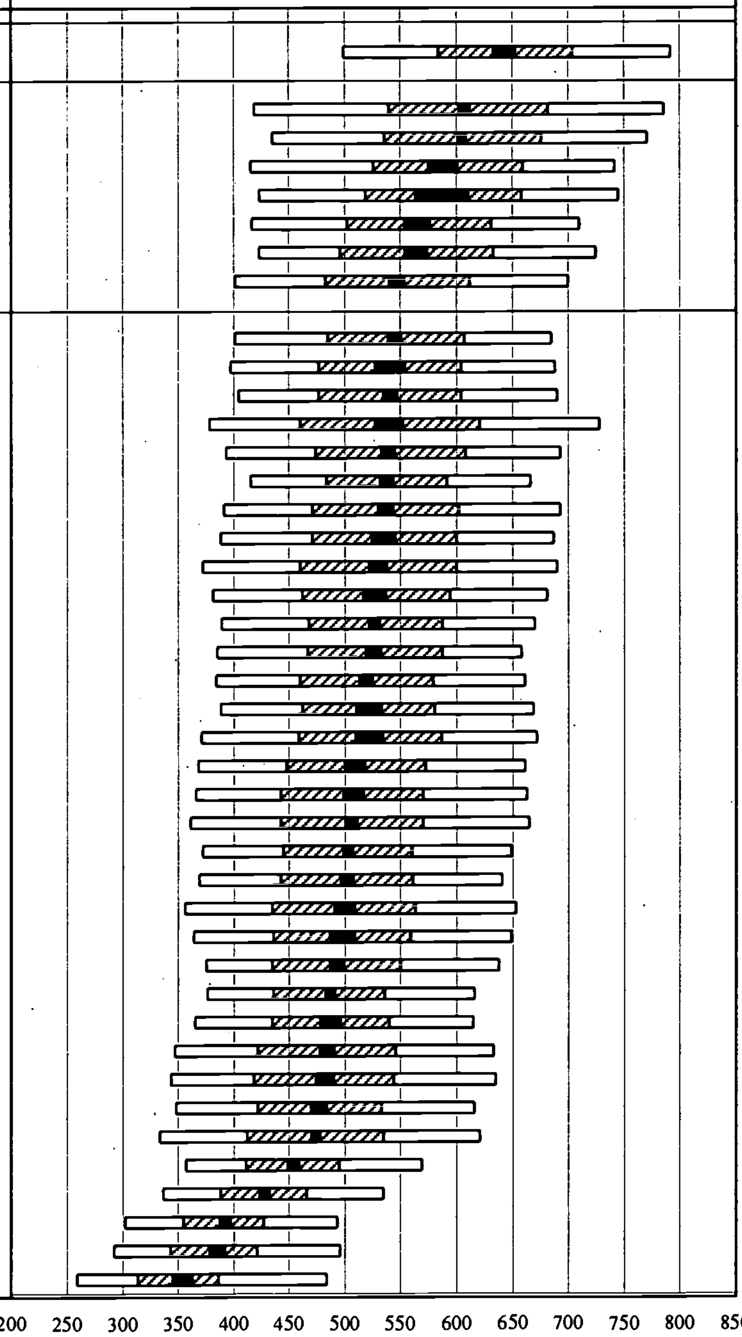
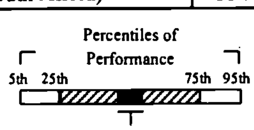
Exhibit B-4: Distributions of Mathematics Achievement in the Eighth Grade

Country	Mean†
— Higher than FiW —	
Singapore	643 (4.9)
— Same as FiW —	
Korea	607 (2.4)
Japan	605 (1.9)
Hong Kong	588 (6.5)
First in the World	587 (11.8)
Belgium-Flemish^	565 (5.7)
Czech Republic	564 (4.9)
Slovak Republic	547 (3.3)
— Lower than FiW —	
Switzerland^	545 (2.8)
(Netherlands)	541 (6.7)
(Slovenia)	541 (3.1)
(Bulgaria)	540 (6.3)
(Austria)	539 (3.0)
France	538 (2.9)
Hungary	537 (3.2)
Russian Federation	535 (5.3)
(Australia)	530 (4.0)
Ireland	527 (5.1)
Canada	527 (2.4)
(Belgium-French)	526 (3.4)
Sweden	519 (3.0)
(Thailand)	522 (5.7)
(Israel)*	522 (6.2)
(Germany)*^	509 (4.5)
New Zealand	508 (4.5)
England*^	506 (2.6)
Norway	503 (2.2)
(Denmark)	502 (2.8)
United States^	500 (4.6)
(Scotland)	498 (5.5)
Latvia {LSS}^	493 (3.1)
Spain	487 (2.0)
Iceland	487 (4.5)
(Greece)	484 (3.1)
(Romania)	482 (4.0)
Lithuania*	477 (3.5)
Cyprus	474 (1.9)
Portugal	454 (2.5)
Iran, Islamic Republic	428 (2.2)
(Kuwait)	392 (2.5)
(Columbia)	385 (3.4)
(South Africa)	354 (4.4)





SOURCE: Student Achievement Data, NCREL; tables 1.1, E.1, and E.3 in Beaton, Albert E., *et al.* (1996). *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

* Nations in which more than 10 percent of the population was excluded from testing. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.

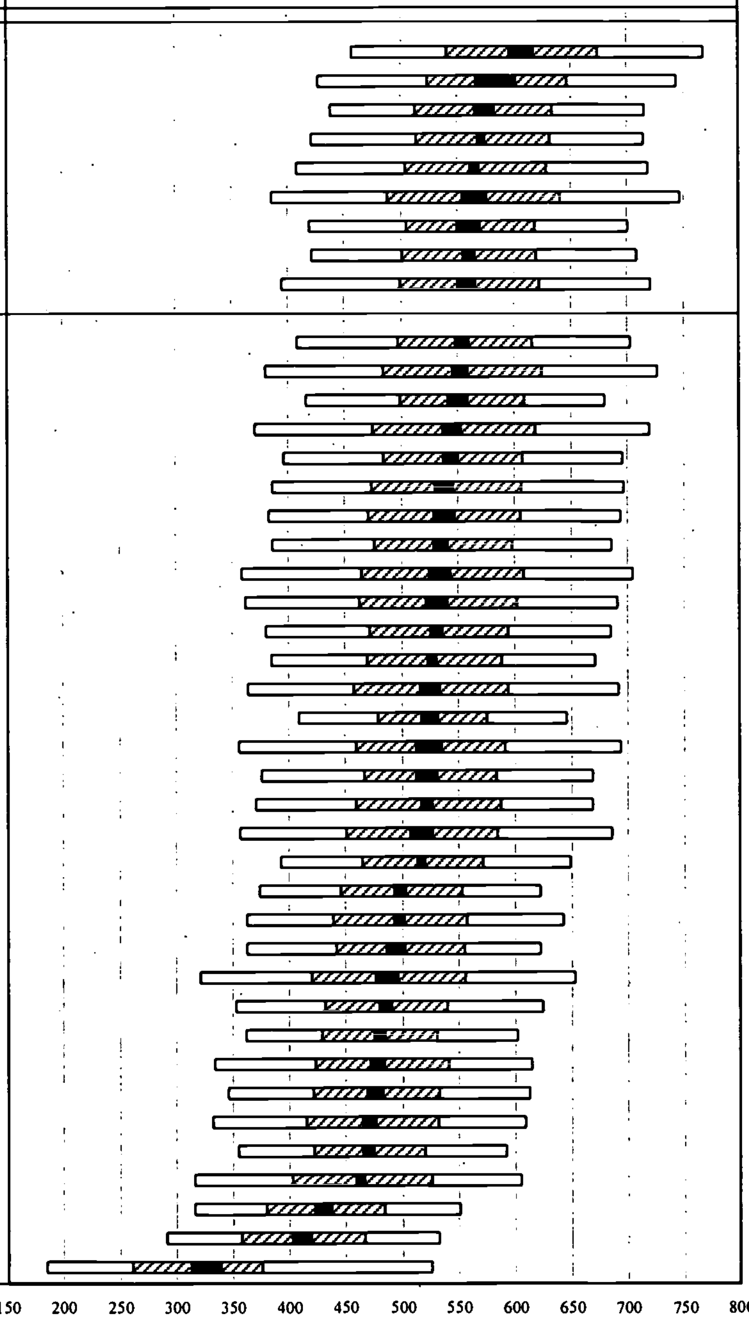
^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

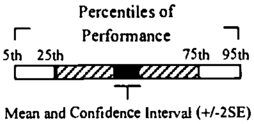
† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

Exhibit B-5: Distributions of Science Achievement in the Eighth Grade

Country	Mean†	Science Achievement Scale Score
Same as FiW		
Singapore	607 (5.5)	
First in the World	584 (8.7)	
Czech Republic	574 (4.3)	
Japan	571 (1.6)	
Korea	565 (1.9)	
(Bulgaria)	565 (5.3)	
(Netherlands)	560 (5.0)	
(Slovenia)	560 (2.5)	
(Austria)	558 (3.7)	
Lower than FiW		
Hungary	554 (2.8)	
England*^	552 (3.3)	
Belgium-Flemish^	550 (4.2)	
(Australia)	545 (3.9)	
Slovak Republic	544 (3.2)	
Russian Federation	538 (4.0)	
Ireland	538 (4.5)	
Sweden	535 (3.0)	
United States^	534 (4.7)	
(Germany)*^	531 (4.8)	
Canada	531 (2.6)	
Norway	527 (1.9)	
New Zealand	525 (4.4)	
(Thailand)	525 (3.7)	
(Israel)*	524 (5.7)	
Hong Kong	522 (4.7)	
Switzerland^	522 (2.5)	
(Scotland)	517 (5.1)	
Spain	517 (1.7)	
France	498 (2.5)	
(Greece)	497 (2.2)	
Iceland	494 (4.0)	
(Romania)	486 (4.7)	
Latvia {LSS}^	485 (2.7)	
Portugal	480 (2.3)	
(Denmark)	478 (3.1)	
Lithuania*	476 (3.4)	
(Belgium-French)	471 (2.8)	
Iran, Islamic Republic	470 (2.4)	
Cyprus	463 (1.9)	
(Kuwait)	430 (3.7)	
(Columbia)	411 (4.1)	
(South Africa)	326 (6.6)	





SOURCE: Student Achievement Data, NCREL; tables 1.1, E.1, and E.3 in Beaton, Albert E., *et al.* (1996). *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

* Nations in which more than 10 percent of the population was excluded from testing. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.

^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

Exhibit B-6: Eighth-Grade Mathematics Performance, by Subtopic

Average Percent Correct

Whole Numbers	
Higher than FiW	
Singapore	80.4
Same as FiW	
Japan	72.0
Switzerland	70.2
Belgium (Fl)	68.6
Korea	67.6
Czech Republic	67.4
First in the World	67.0
Hong Kong	65.4
France	64.5
Russian Federation	62.7
Spain	60.8
Hungary	60.6
Sweden	58.9
Israel	59.0
Canada	57.9
Lower than FiW	
Thailand	56.0
INTERNATIONAL	55.5
Germany	55.4
Australia	55.0
Netherlands	53.5
Norway	53.4
United States	52.3
New Zealand	48.6
England	46.8

Common Fractions	
Higher than FiW	
Singapore	82.4
Same as FiW	
Japan	72.2
Korea	69.9
Hong Kong	69.4
Belgium (Fl)	68.7
First in the World	65.8
Switzerland	62.4
Czech Republic	59.6
Netherlands	58.9
France	57.8
Hungary	57.7
Israel	57.4
Lower than FiW	
Canada	56.2
Australia	55.4
Russian Federation	55.8
Thailand	54.2
Sweden	53.1
INTERNATIONAL	52.1
Germany	51.7
New Zealand	51.5
Norway	51.2
United States	49.3
England	49.2
Spain	49.2

Decimal Fractions & Percentages	
Same as FiW	
Singapore	77.9
First in the World	73.8
Czech Republic	72.5
Hong Kong	71.1
Japan	69.8
Hungary	68.7
Korea	68.4
Lower than FiW	
Russian Federation	65.9
France	64.9
Belgium (Fl)	64.6
Switzerland	61.9
Canada	61.0
Sweden	59.2
Thailand	58.0
Netherlands	57.8
Germany	57.2
Israel	56.3
United States	55.8
INTERNATIONAL	55.4
Norway	54.1
Australia	53.5
Spain	50.6
New Zealand	49.3
England	45.9

Relationships of Fractions	
Same as FiW	
Singapore	85.1
First in the World	78.3
Korea	77.6
Japan	75.3
Hong Kong	74.1
Belgium (Fl)	71.3
Lower than FiW	
Switzerland	70.0
France	67.2
Canada	65.1
Czech Republic	64.9
Germany	62.6
Sweden	62.2
Australia	61.0
Hungary	60.7
Norway	59.6
Netherlands	62.5
Thailand	59.6
Russian Federation	59.2
United States	58.5
Israel	57.6
INTERNATIONAL	56.9
New Zealand	56.8
England	53.8
Spain	48.2

Estimations of Quantity & Size	
Same as FiW	
Japan	77.9
Singapore	77.3
First in the World	76.2
England	72.2
Hong Kong	71.8
Switzerland	71.8
Czech Republic	71.7
Netherlands	71.2
Belgium (Fl)	70.7
Korea	70.7
Australia	69.3
Hungary	69.3
Sweden	69.3
France	69.0
Germany	69.0
Lower than FiW	
Canada	67.8
Norway	66.6
New Zealand	65.3
Russian Federation	63.5
United States	62.7
INTERNATIONAL	61.0
Israel	58.4
Thailand	57.1
Spain	54.8

Rounding	
Same as FiW	
First in the World	89.1
Czech Republic	86.9
Singapore	86.6
Canada	84.7
Korea	83.8
Lower than FiW	
Belgium (Fl)	81.0
Hungary	79.8
Japan	79.6
United States	79.2
Netherlands	78.5
Sweden	78.5
Australia	77.5
Switzerland	77.4
Thailand	75.4
France	74.7
New Zealand	74.4
Hong Kong	74.2
England	74.2
Russian Federation	73.5
Norway	72.3
INTERNATIONAL	70.7
Germany	69.9
Israel	68.8
Spain	62.2

Estimating Computations	
Same as FiW	
Singapore	75.8
First in the World	74.5
Czech Republic	69.8
Japan	69.0
Korea	66.7
Lower than FiW	
Belgium (Fl)	64.1
Switzerland	62.5
Canada	61.3
Sweden	60.0
Australia	59.1
Netherlands	58.7
Hong Kong	57.8
New Zealand	57.6
Hungary	57.3
Norway	57.0
United States	55.7
England	54.4
Germany	52.0
Israel	51.9
France	50.8
INTERNATIONAL	50.6
Russian Federation	50.0
Thailand	49.5
Spain	44.1

Measurement Units	
Higher than FiW	
Singapore	77.9
Same as FiW	
Japan	74.8
Czech Republic	73.2
Belgium (Fl)	71.8
Switzerland	71.6
Sweden	69.5
France	69.0
Korea	67.9
Hungary	67.5
Netherlands	66.8
First in the World	66.4
Norway	66.4
Russian Federation	65.9
Australia	65.0
Hong Kong	65.2
Germany	63.5
Canada	63.0
Israel	63.0
Spain	62.4
Thailand	62.3
INTERNATIONAL	61.4
New Zealand	61.3
England	60.5
Lower than FiW	
United States	53.0

Perimeter, Area, Volume	
Higher than FiW	
Singapore	84.5
Japan	72.6
Same as FiW	
Hong Kong	63.9
Korea	61.8
First in the World	49.9
Czech Republic	48.9
Switzerland	46.6
Belgium (Fl)	45.6
France	44.1
Hungary	42.9
Russian Federation	44.6
Netherlands	44.0
Australia	42.1
Canada	40.4
Thailand	40.0
Sweden	39.3
INTERNATIONAL	39.0
England	37.1
Israel	36.9
Lower than FiW	
Norway	36.4
New Zealand	35.0
Germany	32.9
Spain	29.9
United States	27.8

Measurement Estimations & Errors	
Higher than FiW	
Czech Republic	82.9
Singapore	81.0
Sweden	80.8
Same as FiW	
Korea	79.5
Belgium (Fl)	78.9
Hungary	78.2
Switzerland	78.2
Netherlands	76.1
France	75.2
First in the World	75.0
Australia	74.5
Norway	74.5
Germany	72.9
Hong Kong	72.7
Japan	72.5
England	71.8
New Zealand	70.6
Canada	69.7
Russian Federation	69.6
Lower than FiW	
Thailand	66.1
INTERNATIONAL	64.7
Israel	63.3
United States	62.5
Spain	55.3

2D Geometry Basics	
Higher than FiW	
Japan	78.9
Same as FiW	
Singapore	78.3
Korea	75.5
Hong Kong	73.5
First in the World	65.0
Russian Federation	63.4
Netherlands	62.9
Thailand	62.4
Czech Republic	62.1
Hungary	61.6
Australia	58.8
Switzerland	57.9
Belgium (Fl)	58.8
France	56.1
New Zealand	55.8
England	54.9
Canada	54.7
INTERNATIONAL	53.8
Israel	52.5
Norway	52.1
Germany	49.3
Lower than FiW	
Spain	49.5
United States	47.9
Sweden	46.1

Polygons & Circles	
Higher than FiW	
Korea	73.0
Japan	70.8
Singapore	70.6
Same as FiW	
Hong Kong	65.4
Belgium (Fl)	64.1
France	61.9
Israel	59.7
Czech Republic	57.4
Russian Federation	57.2
First in the World	56.1
Thailand	53.5
Hungary	51.6
Canada	50.5
Australia	50.4
INTERNATIONAL	48.9
Switzerland	48.6
England	47.0
Netherlands	44.0
Lower than FiW	
Germany	44.3
New Zealand	43.2
Sweden	42.8
Norway	42.4
Spain	39.3
United States	39.1

3D Geometry & Transformations	
Same as FiW	
Japan	84.3
Singapore	78.6
First in the World	78.0
Czech Republic	77.7
France	77.7
Hong Kong	77.6
Switzerland	75.9
Belgium (Fl)	73.7
Korea	73.3
Hungary	71.0
Netherlands	70.6
Russian Federation	70.2
Canada	70.1
Lower than FiW	
New Zealand	67.3
England	66.3
Australia	65.5
Israel	64.8
Thailand	64.5
Germany	63.7
INTERNATIONAL	63.6
Norway	58.6
United States	58.4
Spain	58.2
Sweden	55.9

Congruence & Similarity	
Higher than FiW	
Japan	79.7
Korea	76.9
Singapore	76.7
Same as FiW	
Hong Kong	71.0
France	69.7
Czech Republic	66.1
Thailand	62.7
Russian Federation	62.3
First in the World	62.2
Belgium (Fl)	57.5
Israel	54.8
Hungary	53.4
Canada	52.8
Netherlands	51.0
Lower than FiW	
INTERNATIONAL	52.6
Switzerland	51.2
Australia	50.9
Norway	46.9
New Zealand	45.9
Sweden	45.9
England	45.6
Germany	45.1
United States	44.1
Spain	43.6

Proportionality Concepts	
Higher than FiW	
Singapore	70.1
Same as FiW	
Korea	57.0
Japan	56.9
First in the World	50.6
Hong Kong	50.1
Netherlands	41.9
Lower than FiW	
Canada	40.3
Sweden	39.2
Belgium (Fl)	39.0
Australia	37.8
France	37.3
Switzerland	36.8
Czech Republic	37.3
Thailand	36.5
England	34.8
Hungary	34.6
Russian Federation	33.5
INTERNATIONAL	33.4
New Zealand	33.4
United States	31.5
Israel	31.4
Norway	30.9
Spain	27.4
Germany	26.5

Proportionality Problems	
Higher than FiW	
Singapore	76.7
Same as FiW	
Japan	67.8
Korea	65.1
Hong Kong	64.0
Czech Republic	61.3
First in the World	61.1
Belgium (Fl)	59.4
Switzerland	57.3
Russian Federation	56.3
Thailand	56.0
Hungary	55.9
Netherlands	55.9
France	55.7
Lower than FiW	
Australia	52.2
Canada	51.6
INTERNATIONAL	50.1
Sweden	49.2
Germany	49.0
England	47.2
New Zealand	47.1
Israel	46.5
Norway	47.1
United States	45.2
Spain	43.6

Patterns, Relations, & Functions	
Same as FiW	
Japan	70.0
Korea	68.4
Singapore	67.2
First in the World	63.2
Hong Kong	60.8
Czech Republic	60.2
England	60.1
Switzerland	59.5
Belgium (Fl)	59.2
Hungary	59.1
Canada	58.2
Australia	57.6
Netherlands	56.9
New Zealand	55.7
France	55.0
Lower than FiW	
Thailand	53.4
Russian Federation	53.2
Israel	53.2
INTERNATIONAL	51.4
United States	51.1
Spain	50.3
Norway	48.7
Germany	47.6
Sweden	47.2

Equations & Formulas	
Higher than FiW	
Singapore	79.8
Same as FiW	
Japan	72.3
Hong Kong	70.5
Korea	70.0
First in the World	67.8
Czech Republic	64.3
Belgium (Fl)	62.1
Russian Federation	61.4
Hungary	60.9
Israel	58.3
Lower than FiW	
Thailand	54.0
France	53.6
Australia	52.8
Canada	52.4
Spain	52.2
Switzerland	51.9
Netherlands	51.7
INTERNATIONAL	50.6
United States	49.4
Germany	46.4
New Zealand	46.6
Norway	44.9
England	44.1
Sweden	43.7

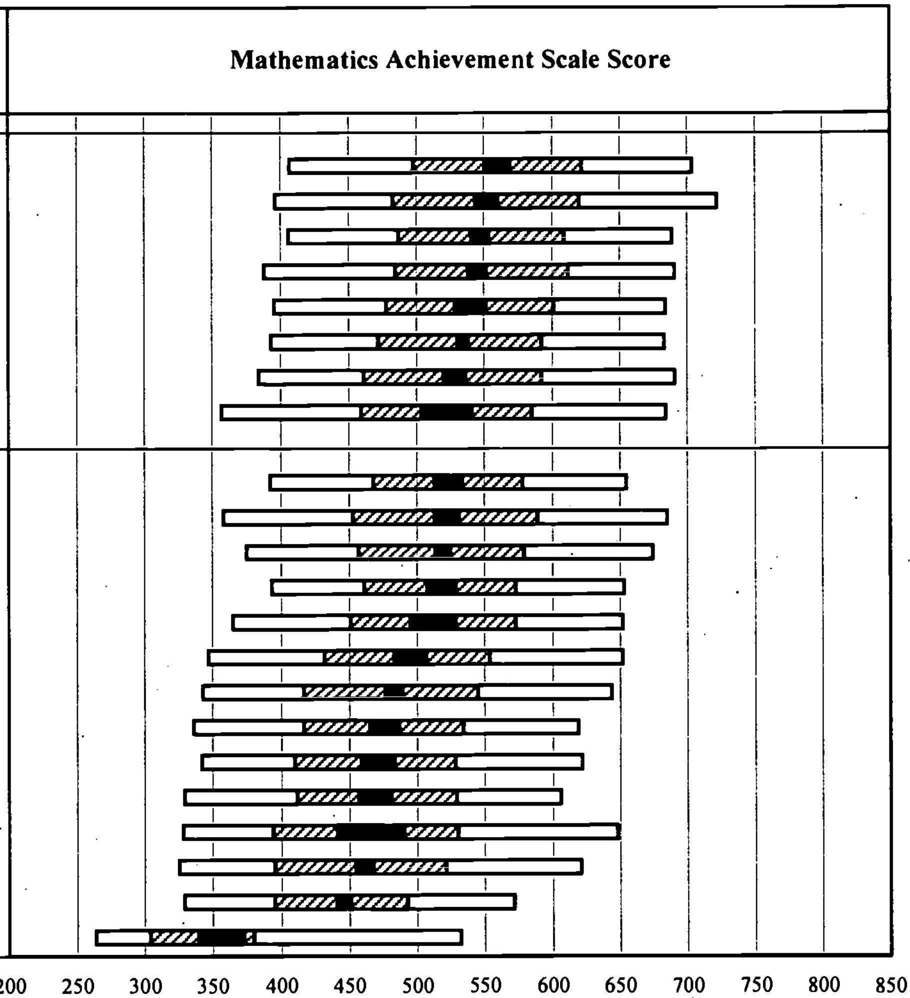
Data Represent. & Analysis	
Same as FiW	
Japan	84.3
First in the World	83.2
Korea	81.9
France	81.4
Switzerland	81.3
Singapore	81.0
Netherlands	80.6
Czech Republic	79.6
Sweden	79.5
Belgium (Fl)	79.5
Hong Kong	76.4
Germany	76.0
Lower than FiW	
Norway	75.5
Australia	75.2
Canada	75.0
England	74.8
Thailand	74.5
New Zealand	74.1
Hungary	73.7
Israel	73.2
United States	72.6
Russian Federation	72.0
INTERNATIONAL	70.9
Spain	70.4

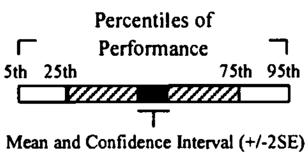
Statistics & Probability	
Same as FiW	
First in the World	81.3
Singapore	78.5
Korea	77.8
Belgium (Fl)	77.7
Japan	75.0
Hong Kong	73.0
Netherlands	72.4
Lower than FiW	
Switzerland	72.4
Canada	70.0
Sweden	68.7
Australia	67.5
France	66.5
Hungary	66.2
New Zealand	65.9
England	65.3
Norway	64.7
Czech Republic	63.4
United States	63.1
Germany	62.4
Israel	62.3
INTERNATIONAL	59.6
Spain	58.0
Russian Federation	56.9
Thailand	56.5

SOURCE: U.S. National TIMSS Center, Michigan State University.

Exhibit B-7: Distributions of General Mathematics Achievement in the Twelfth Grade

Country	Mean†
Same as FiW	
(Netherlands)*	560 (4.7)
Sweden	552 (4.3)
(Denmark)	547 (3.3)
First in the World	545 (3.5)
Switzerland	540 (5.8)
(Iceland)	534 (2.0)
(Norway)	528 (4.1)
(Australia)	522 (9.3)
Lower than FiW	
(France)	523 (5.1)
New Zealand^	522 (4.5)
(Canada)	519 (2.8)
(Austria)*	518 (5.3)
(Slovenia)	512 (8.3)
(Germany)^	495 (5.9)
Hungary	483 (3.2)
(Italy)	476 (5.5)
Russian Federation*	471 (6.2)
Lithuania	469 (6.1)
Czech Republic	466 (12.3)
(United States)	461 (3.2)
Cyprus*	446 (2.5)
(South Africa)	356 (8.3)





SOURCE: Student Achievement Data, NCREL; tables 2.1, E.2, and E.7 and figure B.4 in Mullis, I.V.S., *et al.* (1998). *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

* Nations in which more than 10 percent of the population was excluded from testing.

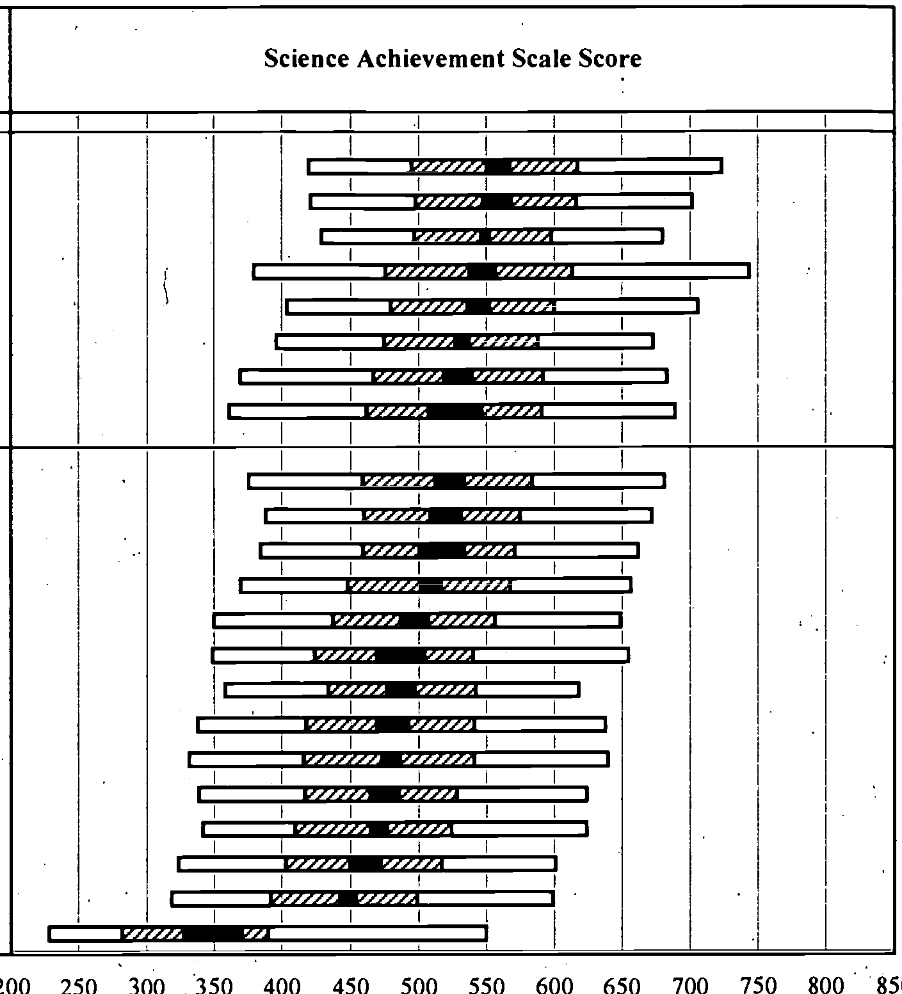
^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

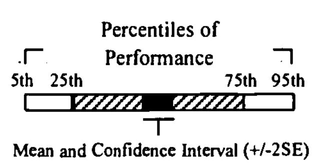
† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

Exhibit B-8: Distributions of General Science Achievement in the Twelfth Grade

Country	Mean†
Same as FiW	
Sweden	559 (4.4)
(Netherlands)*	558 (5.3)
(Iceland)	549 (1.5)
First in the World	547 (4.8)
(Norway)	544 (4.1)
(Canada)	532 (2.6)
New Zealand^	529 (5.2)
(Australia)	527 (9.8)
Lower than FiW	
Switzerland	523 (5.3)
(Austria)*	520 (5.6)
(Slovenia)	517 (8.2)
(Denmark)	509 (3.6)
(Germany)^	497 (5.1)
Czech Republic	487 (8.8)
(France)	487 (5.1)
Russian Federation*	481 (5.7)
(United States)	480 (3.3)
(Italy)	475 (5.3)
Hungary	471 (3.0)
Lithuania	461 (5.7)
Cyprus*	448 (3.0)
(South Africa)	349 (10.5)





SOURCE: Student Achievement Data, NCREL; tables 2.2, E.3, and E.8 and figure B.4 in Mullis, I.V.S., *et al.* (1998). *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

* Nations in which more than 10 percent of the population was excluded from testing.

^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

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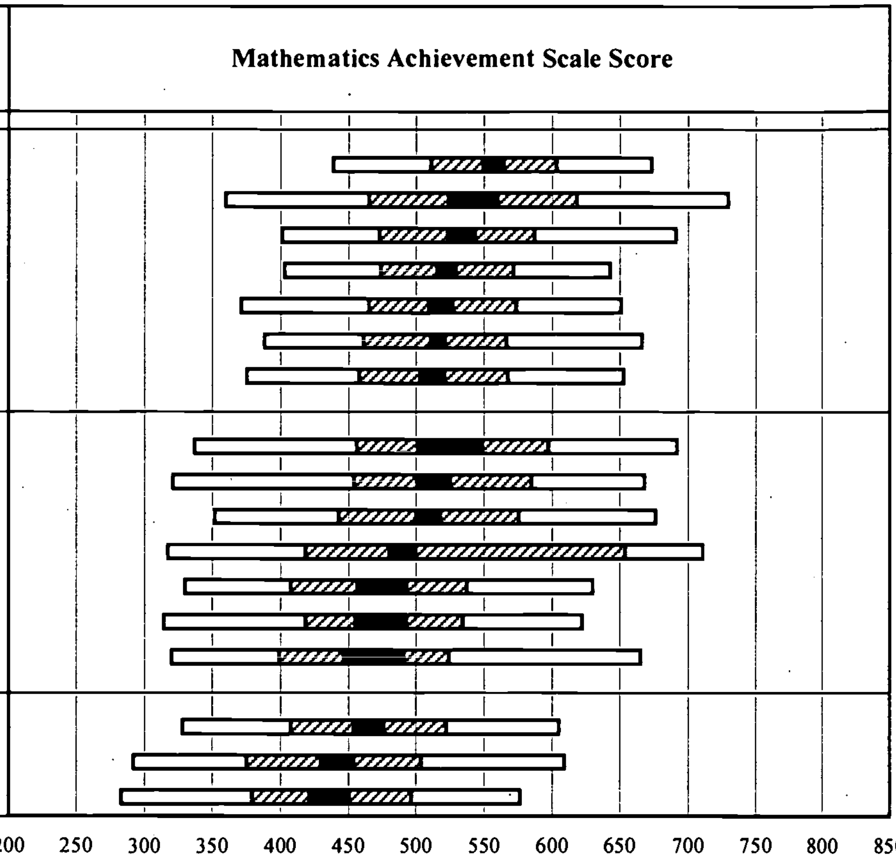
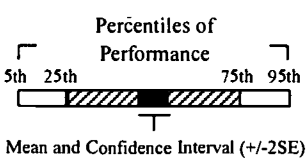
Exhibit B-9: Distributions of Advanced Mathematics Achievement in the Twelfth Grade[1]

Country	Mean†
Higher than FiW	
France	557 (3.9)
Russian Federation*	542 (9.2)
Switzerland	533 (5.0)
(Denmark)	522 (3.4)
Cyprus*	518 (4.3)
Lithuania	516 (2.6)
Sweden	512 (4.4)
Same as FiW	
(Australia)	525 (11.6)
Greece^	513 (6.0)
Canada	509 (4.3)
First in the World	490 (4.9)
(Slovenia)	475 (9.2)
(Italy)	474 (9.6)
Czech Republic	469 (11.2)
Lower than FiW	
Germany^	465 (5.6)
(United States)	442 (5.9)
(Austria)*	436 (7.2)





SOURCE: Student Achievement Data, NCREL; tables 5.1, E.4, and E.9 and figure B.5 in Mullis, I.V.S., *et al.* (1998). *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

[1] Approximately 19 percent of the international school leaving age cohort, 14 percent of the U.S. cohort, and 65 percent of the FiW cohort were cover by the TIMSS sample for this assessment.

* Nations in which more than 10 percent of the population was excluded from testing.

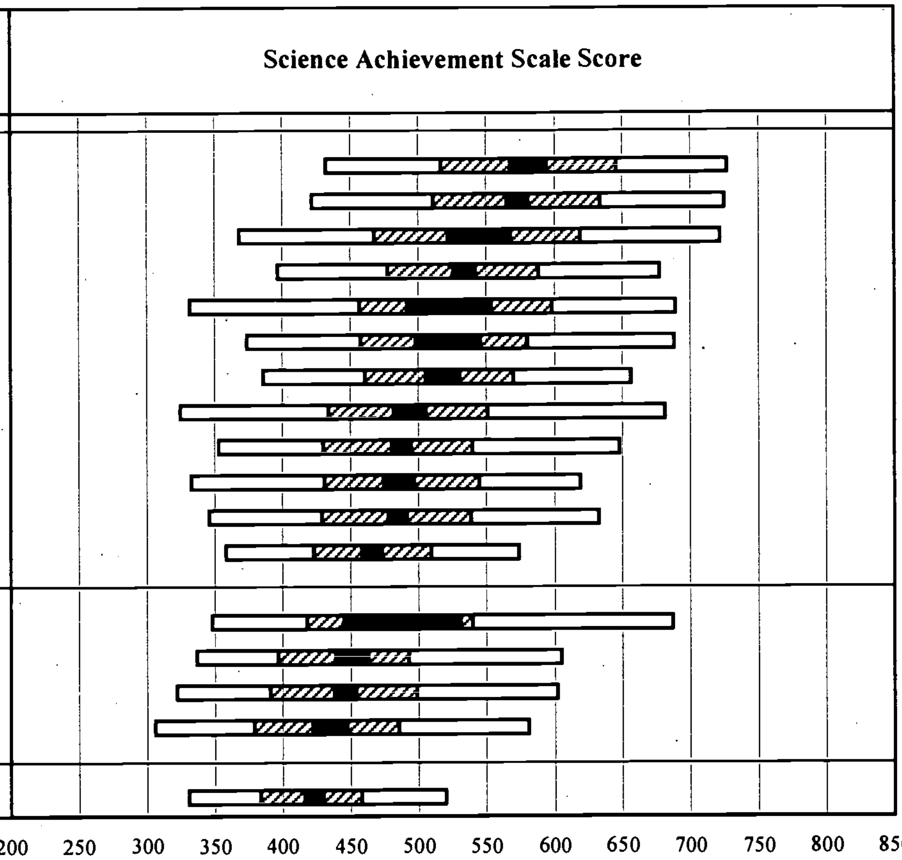
^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

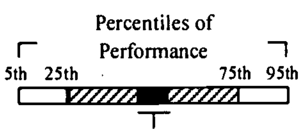
† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

Exhibit B-10: Distributions of Advanced Science (Physics) Achievement in the Twelfth Grade[1]

Country	Mean†
Higher than FiW	
Norway^	581 (6.5)
Sweden	573 (3.9)
Russian Federation*	545 (11.6)
(Denmark)	534 (4.2)
(Slovenia)	523 (15.5)
Germany^	522 (11.9)
(Australia)	518 (6.2)
Cyprus*	494 (5.8)
Switzerland	488 (3.5)
Greece^	486 (5.6)
Canada	485 (3.3)
France	466 (3.8)
Same as FiW	
Latvia (LSS)	488 (21.5)
Czech Republic	451 (6.2)
First in the World	446 (4.1)
(Austria)*	435 (6.4)
Lower than FiW	
(United States)	423 (3.3)





SOURCE: Student Achievement Data, NCREL; tables 8.1, E.5, and E.10 and figure B.6 in Mullis, I.V.S., *et al.* (1998). *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

[1] Approximately 13 percent of the international school leaving age cohort, 15 percent of the U.S. cohort, and 67 percent of the FiW cohort were cover by the TIMSS sample for this assessment.

* Nations in which more than 10 percent of the population was excluded from testing. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.

^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

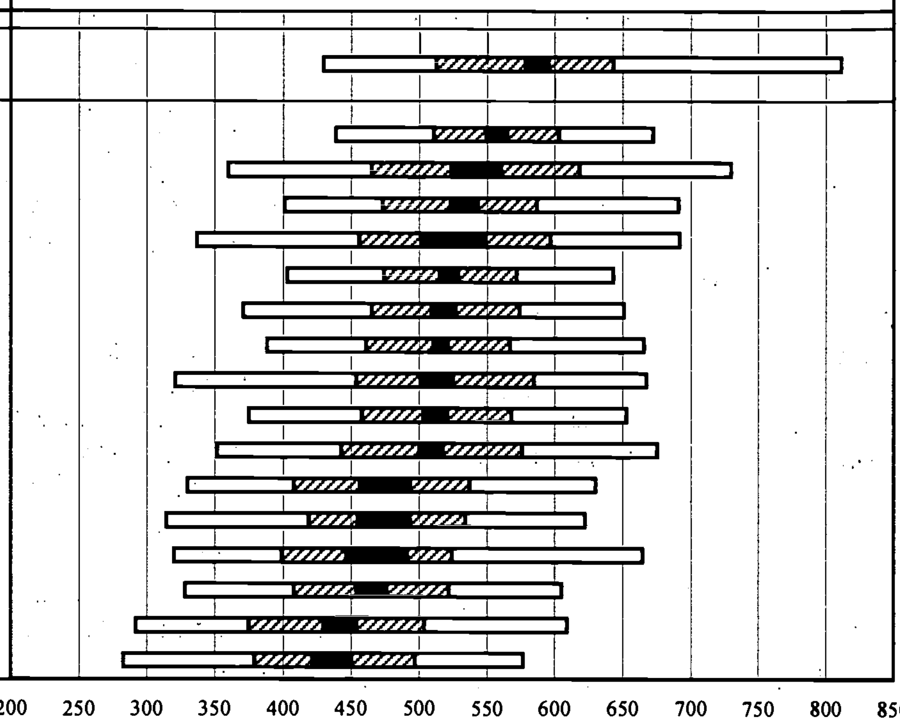
† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

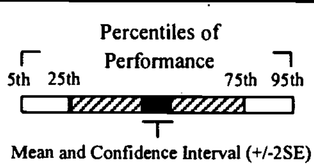
NOTE: Nations not meeting international guidelines are shown in parentheses.

Exhibit B-11: Distributions of Advanced Mathematics Achievement for Twelfth-Grade FiW AP Students[1]

Country	Mean†
Same as FiW AP	
First in the World AP	587 (4.3)
Lower than FiW AP	
France	557 (3.9)
Russian Federation*	542 (9.2)
Switzerland	533 (5.0)
(Australia)	525 (11.6)
(Denmark)	522 (3.4)
Cyprus*	518 (4.3)
Lithuania	516 (2.6)
Greece^	513 (6.0)
Sweden	512 (4.4)
Canada	509 (4.3)
(Slovenia)	475 (9.2)
(Italy)	474 (9.6)
Czech Republic	469 (11.2)
Germany^	465 (5.6)
(United States)	442 (5.9)
(Austria)*	436 (7.2)

Mathematics Achievement Scale Score





SOURCE: Student Achievement Data, NCREL; tables 5.1, E.4, and E.9 and figure B.5 in Mullis, I.V.S., *et al.* (1998). *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

[1] Approximately 19 percent of the international school leaving age cohort, 14 percent of the U.S. cohort, and 28 percent of the FiW cohort were cover by the TIMSS sample for this assessment.

* Nations in which more than 10 percent of the population was excluded from testing.

^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

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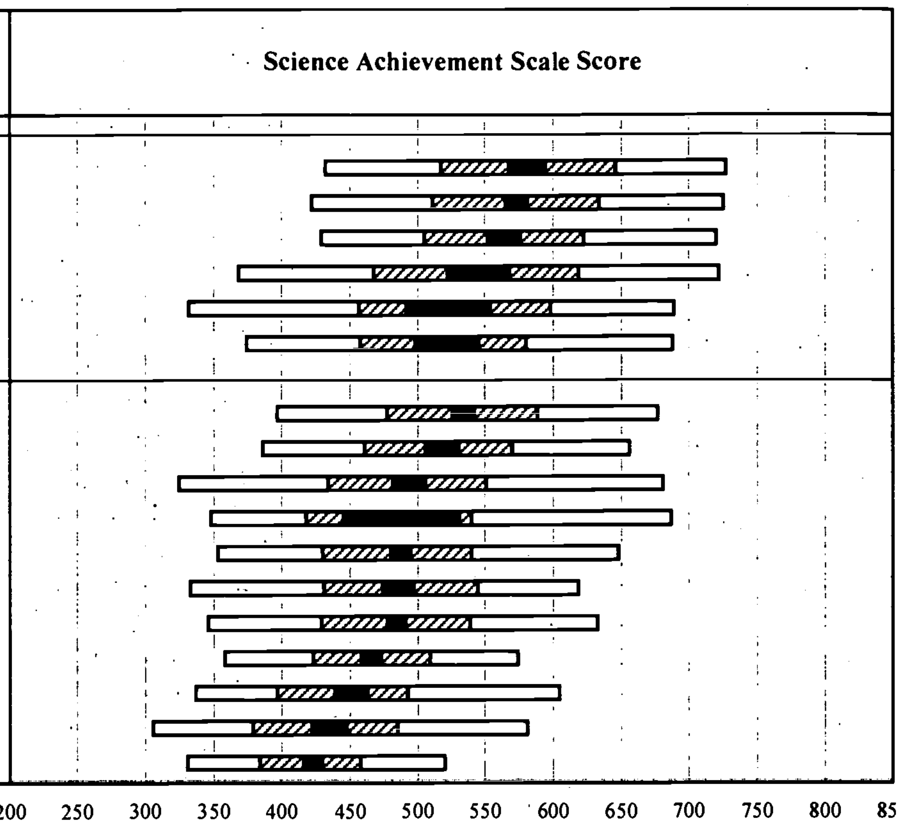
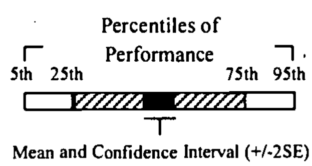
Exhibit B-12: Distributions of Advanced Science (Physics) Achievement for Twelfth-Grade FiW AP Students[1]

Country	Mean†
Same as FiW AP	
Norway^	581 (6.5)
Sweden	573 (3.9)
First in the World AP	564 (5.9)
Russian Federation*	545 (11.6)
(Slovenia)	523 (15.5)
Germany^	522 (11.9)
Lower than FiW AP	
(Denmark)	534 (4.2)
(Australia)	518 (6.2)
Cyprus*	494 (5.8)
Latvia (LSS)	488 (21.5)
Switzerland	488 (3.5)
Greece^	486 (5.6)
Canada	485 (3.3)
France	466 (3.8)
Czech Republic	451 (6.2)
(Austria)*	435 (6.4)
(United States)	423 (3.3)





SOURCE: Student Achievement Data, NCREL; tables 8.1, E.5, and E.10 and figure B.6 in Mullis, I.V.S., *et al.* (1998). *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

[1] Approximately 13 percent of the international school leaving age cohort, 15 percent of the U.S. cohort, and 7 percent of the FiW cohort were covere by the TIMSS sample for this assessment.

* Nations in which more than 10 percent of the population was excluded from testing. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.

^ Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted.

† Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

NOTE: Nations not meeting international guidelines are shown in parentheses.

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